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THE BOSTON SUBWAY.

A considerable advance in the science of transportation of passengers to and through crowded urban districts has been marked by the construction of the Boston subway. Its use in part or in whole for the last year and a half has proven that it most effectively accomplishes the purpose for which it was intended, namely, the relief of the streets it parallels of their excessive overcrowding and the provision of an unobstructed, safe, speedy and comfortable route for the surface cars through the business centre.

Structures of this kind, costing several million dollars, with a probable life of many scores of years, and not admitting of ready change of the general plan, are justly the subjects of great study before their construction is commenced. That in Boston was primarily intended to effect the removal of the electric cars from the streets above it and also to carry cars from an elevated road which will soon be built. Undoubtedly, however, it will be called upon before its useful existence ceases for a service the volume of which is now little appreciated, and the nature of which may be quite different from that for which it was planned. The general desiderata of urban transit are quite changed from what they were a few years ago. Then there were everywhere at least two distinct systems of transportation, one the steam roads, operating on private rights of way, and the other horse roads in the public streets, the one supplementing and feeding the other. Now the development of a power applicable to both has brought them into competition with each other. The street railway has stretched out and paralleled the steam road, and the latter must, if it wishes to retain its short-haul traffic, adopt the power of its rival, by which it can extend itself further into the urban centres and parallel the lines of the street railway.

The Boston subway accommodates the street-car system and assists it in its rivalry with the steam roads. To be sure, the latter could not with the steam power that they use at present operate satisfactorily in a subway, but in the future they will undoubtedly adopt electric power, which would remove this difficulty. The Metropolitan District Railway in London resembles in its structural features the Boston subway; it accommodates trains from the suburban lines of the steam railroads, but no cars or trains run from it into the public highways on the surface. Any general scheme for the amelioration of traffic congestion by means of subways should be planned for both. The disadvantage of change of cars at the city termini from the suburban train to the street car is so great that the railroads go to an enormous expense to bring their termini into the very heart of the city. As the city grows even this does not give them the needed proximity to the centres of business, shopping and population, and overhead or underground loops, with several stopping places, are found necessary. The desire for continuous transit without change of cars has been evidenced by the recent changes on the Brooklyn Bridge. The trolley lines of Brooklyn have been extended over the bridge, and the bridge tracks themselves have been turned into an extension of the elevated railways. Finally, the Long Island Railroad Company has made arrangement to connect its line with the elevated and thereby give accommodations without change of cars from the heart of the city to the suburbs.

THE STARTING OF ROTARY CONVERTERS.

The rotary converter being—so far as its relation to the alternating-current system with which it is connected is concerned—a synchronous motor, is subject to the peculiar difficulties of the lat-

ter in starting, modified by several factors due to its own comparative complexity, the presence of a commutator, etc. Where the machine is used to deliver power from a direct-current system to an alternating-current system there is no question of the most satisfactory method of starting, which is as a shunt-wound, direct-current motor, with the customary resistance inserted in the armature circuit while the speed is low. When the machine delivers power from the alternating to the direct-current side it may be started in the same way, provided there is another independent source of direct current, such as a storage battery, another rotary or a mechanically driven, direct-current generator, the supply of current from which can be depended upon. So satisfactory is this method of starting and so comparatively unsatisfactory is the starting effected from the alternating side that in many instances rotaries necessarily fitted with arrangements for starting from the latter, owing to the possible absence of direct current, are also fitted with starting boxes, by which they may be started as direct-current motors whenever the conditions allow it. As the only load against which they must start is their own friction, the starting box becomes very simple, a variable resistance being unnecessary, as a fixed resistance may be chosen sufficiently high to prevent a current so heavy as to disturb the system being drawn when the circuit is closed with the rotary armature at standstill, and yet sufficiently low to bring the machine up so near to speed against its friction load that the resistance may be short-circuited in one step without disturbance of the regulation or injury to the converter. With any such means of starting there must be used some method of indicating synchronism, such as the common phasing lamps. The adjustment of the machine to synchronism is most effectively accomplished by manipulating the field rheostat, which varies the speed of the machine with precision, since it is running as a shunt motor.

In the majority of places where rotary converters are used they are the only sources of direct current; hence, when shut down, there is no means of starting them except by the use of alternating currents. There are in general three methods of accomplishing this result. The Westinghouse Electric & Manufacturing Company prefers the use of a separate starting motor of the induction type, this motor being of small size compared with the converter itself, as its only load is the friction of the latter. The rotor of the starting motor is generally mounted directly on an extension of the converter shaft, and the starting motor is wound with a smaller number of poles than the converter, in order that with the slip due to the load it shall bring the latter up to or slightly above synchronism. Early equipments put out by this company were fitted with primary windings on the rotating part of the starting motor supplied through collector rings and fixed secondary circuits closed through adjustable resistances, by which the torque could be varied at will. More recent machines are fitted with the usual fixed external primary, and a secondary without collector rings, but with a sufficient resistance in its internally closed circuits to give a high torque at standstill. This resistance starts the machine promptly and cuts down the torque greatly as the starting motor approaches the normal slip occasioned by the friction and the converter approaches synchronism, the machine passing synchronous speed very gradually with slow beats of the phasing lamps, giving the attendant a good opportunity to close the main switch. As there is in this system no connection between the converter windings and the alternating-current supply during starting, the field may be built up—just as is the field of any mechanically driven, shunt-wound generator—to the proper strength, so that when the main switch, supplying alternating currents to the converter, is closed there is no disturbance of the system. The machine is no more and no less likely to come up with its polarity reversed than is any mechanically operated generator.

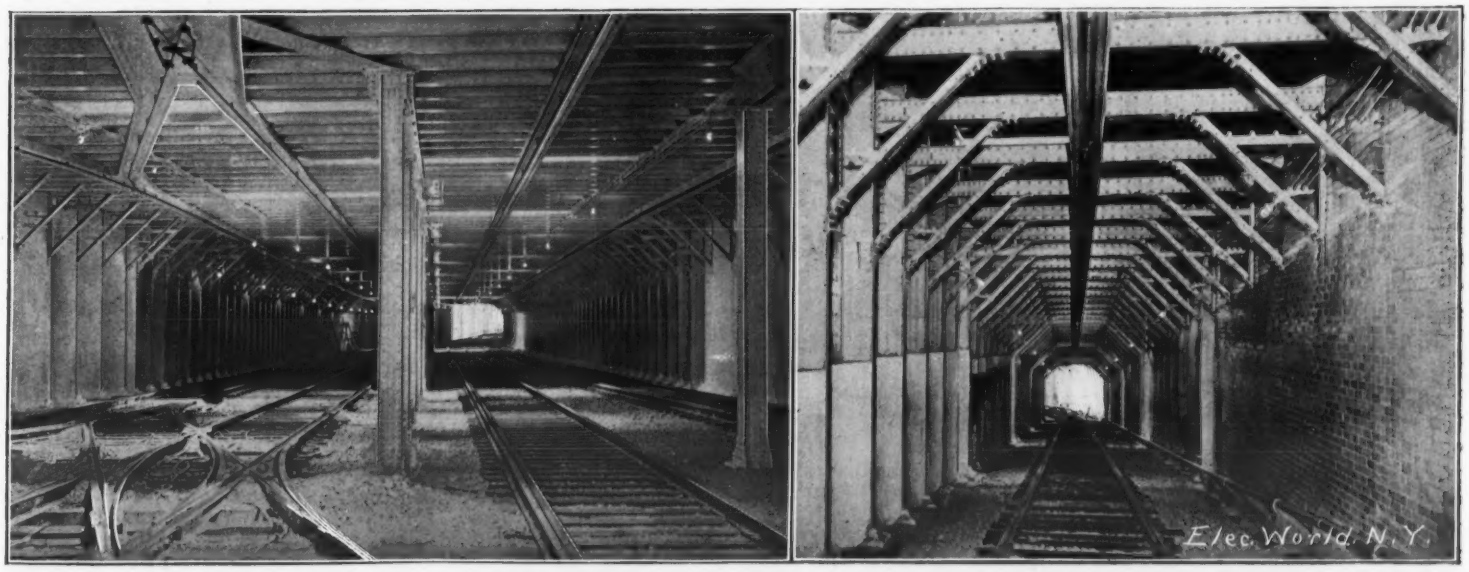
The method of starting preferred by the General Electric Company is the same as that advised for use with synchronous motors of its make, used in situations where they can be started without load, namely, the connection of the armature windings to the alternating-current circuits, producing in the former a rotating field which reacts upon the pole-pieces, giving a torque sufficient to start the machine. As a rule, the direct connection of the collector rings of a rotary across the mains at standstill would draw so heavy an alternating current as to seriously disturb the system, so that reactive coils or other devices must necessarily be inserted. For the satisfactory operation of this method the rotary must be built with a narrow air gap, or the current necessary to magnetize it to a density which will give the torque required to overcome even frictional resistance will be excessive. At best the starting current is considerably more than the full-load rated current, and almost entirely wattless. Wide pole-faces embracing a large percentage of the total periphery of the armature improve the starting with this method, and as such pole-shoes and a narrow gap go with a machine having high armature reaction, rotaries with this quality start better by this means than do those with stiff fields. Solid pole-pieces are found to be preferable in order to prevent "pumping," which, in rotaries of high armature reaction, often becomes so severe as to cause the machine to completely "flop" over, as the action is expressively called, the term signifying that the machine loses or gains a whole period on the alternating current supplying it. The volt amperes actually used in starting are the same whether the pole-piece is laminated or solid, the torque in the former case being due to the hysteresial lag of the field in the pole-pieces, and in the latter case to the same action combined with a drag due to the current circulated in the iron of the pole-pieces, which serves as a short-circuited secondary. In the latter case a greater current is required, which may often be supplied at a lower voltage than normal, as by the use of voltage-reducing transformers, thereby cutting down the demand upon the line, which is apt to be excessive. This general method of starting requires also that the field windings shall be open in order that they shall not act as short-circuited secondaries, and generally that the shunt field windings shall be open in several places in order to cut down the excessive voltage which would be generated in their many turns by the alternating flux forced through the field circuit while the armature is at low speeds. This voltage in a 500-volt rotary might amount to several thousand volts, and is generally provided against by multipolar switches, which, when open, sever the series connections between the several field spools, insulating them electrically from each other, so that the difference of potential between any two parts of the winding is only that generated in one spool. The series winding of a compound-wound field also tends to act as a short circuit, the current finding its way through the shunt by which the compounding is adjusted. This requires the insertion of a switch in this circuit, which must be opened before starting the machine. This method of starting, however, requires no synchronizing apparatus. When a machine approaches synchronous speed the actual velocity of the rotating field generated by the armature becomes less and less with respect to the field poles, until finally the flux generated by the armature locks into the field circuit, after which the machine runs at synchronism with a field magnetism generated by wattless lagging currents. The normal field excitation may then be built up by closing the circuit of the field windings and cutting out the series resistance. Then the reactive coils, if they have been used in the connections to the armature for starting, may be short-circuited, or, if a special low-voltage transformer has been used, the connections may be changed to give the proper voltage. Thus no phasing lamps are necessary, the machine synchronizing itself. The short circuiting under the brushes of coils in which there is a considerable difference of potential, owing to the rotating field, seems to give no trouble. It is noticeable that the rotating field may lock in with either polarity of the field structure, thus reversing the direction of the electromotive force generated between the brushes on the commutator. If the machine is separately excited from the bus bars its armature will "flop" to the right position when the field is excited, while, if it is self-excited from its own brushes, its reverse polarity will be maintained when the field circuit is closed, and the machine will become a short circuit if thrown in multiple with others.

Another method of starting that has been used with some success is the temporary connection of the armature through the commutator in series with the series field and across one phase of the alternating-current supply. This makes the machine a regular series motor, the polarity of both armature and fields of which alternate simultaneously, maintaining the tendency to rotate in one direction. The machine can be readily made to generate sufficient torque to start against friction by this arrangement, but tends, of course, to run away, as does any series motor, so that it is somewhat difficult to steady it at synchronism with sufficient precision to find a time when the connections can be changed over for permanent running.

The streets in the downtown district of the city of Boston were until a few years ago perhaps the most congested of any urban thoroughfares the world over. This is due to the unique combination—found nowhere else in such a degree—of the narrow, crooked streets characteristic of European cities and following the primitive paths laid out a century or more ago, lined with the busy office and shopping structures characteristic of American cities. To the northerly side of the business district were four railway terminals, while to the south were four more, with between the two a general jumble of surface traffic, a large part of which was made up of trolley cars, picking their way slowly and with many blockades through the narrow, tortuous streets. The patience of even conservative New Englanders was finally exhausted, the opposition of those who opposed any violation of the sacred Common was overcome, and in 1894 a statute was enacted by the Massachusetts Legislature embodying the Boston Transit Commission and authorizing it among other things to construct an underground route for the street railways. Traffic conditions are now quite revolutionized from their state of four years ago. One union station has replaced the four small depots at the northern end of the city, and another mammoth terminal is now used by two of the railroads running out to the south, and will, before the next new year, be used by all four. The underground route of the street railways is in full operation, the tracks are removed from the surface and an elevated road to connect the two railway terminals will soon be under construction.

The subway, the route of which is shown by the map on the accompanying supplemental sheet, is about two miles in length, in part a two and in part a four-track structure, running from an inclined approach near the Northern Union Station, under the streets and malls, skirting the Common and forking in two directions to the south and west. As it is designed to carry through cars from the surface and from future elevateds, both of which will enter it by inclines, it is necessarily placed immediately below the street level, the distance between the rails of the subway and the surface being, as a rule, from 16 to 20 feet, the height of the subway itself being 14 feet. The nature of the construction differs greatly from point to point, there being three distinct types of side walls and roof. One of these, known as the wide-arch type, is constructed almost entirely of masonry, the arch spanning two tracks. Another, known as the double-barrel arch type, has two arches, each spanning the distance from one side wall to a centre wall. A view of these constructions is given in the left-hand illustration at the head of this page, a wide arch in the foreground joining a double-barrel arch in the background. The third style is known as the steel and masonry combined type, the roof being of jack arches of masonry resting on steel I-beams running across the subway, and supported by steel columns, between and around which is concrete forming the side walls. This construction, in one, two and four-track widths, is shown in the illustrations on this page and that following.

The masonry-arch type has the advantage of lower depreciation, and may be constructed piecemeal with much smaller openings in the surface, but is liable to be crippled by unequal loading. To minimize the last disadvantage horizontal, transverse steel tie-rods, shown clearly in the illustration and drawings, are used above the 14-foot minimum roof limit. The combined steel and masonry type is liable to a more rapid depreciation through rust, which is provided against in the subway by a thorough bedding in cement concrete. Electrolysis is another danger to which it is exposed, and which has been the subject of special study. It required a greater street disturbance for its construction, but was in many places absolutely necessitated by the clear width needed and the lack of vertical room for arches spanning this width. The frame-



FOUR-TRACK AND SINGLE-TRACK SECTIONS OF THE SUBWAY OF THE COMBINED STEEL AND MASONRY TYPE.

work is of open-hearth steel, and designed to carry, beside the dead-load of the roof and earth and paving above it, a steam road roller weighing 50,000 pounds, surrounded by a crowd of people weighing 100 pounds to the square foot, or as many electric cars, weighing 18 tons apiece, as could be brought over the structure, all intervening and surrounding space being filled with a similar crowd of people.

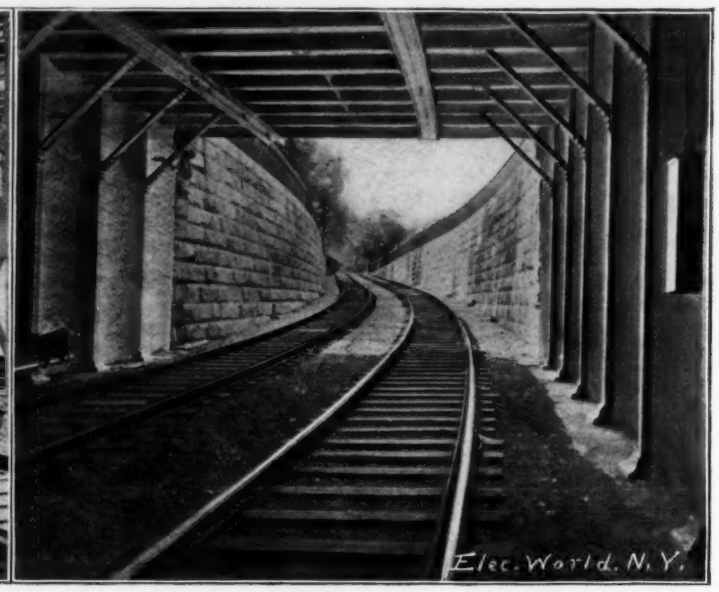
The subway is planned not only to give through routes from the inclined approaches at one end to that at the other, but also contains loops by which the cars may reach a terminus within the subway and return. No track crossings are allowed at grade, so that where a double-track line forks one track must be carried over or under another. On this account, and because of the curves, the interference of subterranean pipes and the variations necessary for stations, the cross-section varies continually. An idea of this may be gained from the cross-sections shown on the lower part of the right-hand page of the accompanying supplement. That designated as No. 5 is taken at the corner of Tremont and Boylston Streets, where one track is below the other, due to its depression under the tracks branching off down Boylston Street. The two tracks here are in two single arches, forming what is termed the double-barrel arch. Further south they come together in the wide arch shown in section No. 11, and run together for some distance until another relative change of level is rendered necessary for the division of the two tracks into four, two running out Shawmut Avenue and two out Tremont Street. The beginning of the divergence of grade is shown in section No. 15. In section No. 18 one track has left a wide arch and entered an arch of its own, while at section 20, the wide arch has become a double-barrel arch, while the track running in the single arch has entered a section of the combined steel and masonry type. Section No. 23 shows the two lower tracks wider apart, the upper track divided; and section No. 25 shows all four in a structure of the combined steel and masonry type and approaching a common level.

The sections of this part of the line give an idea of the necessary change of piping and of the construction of the several types of the subway. The side walls and invert of the arch are of concrete with at frequent intervals refuge niches in the walls and with a brick arch covered with concrete overhead. In the wide-arch type this is stiffened by tie-rods to prevent collapse under unequal loading. Wherever the subway lies below the ground-water level a sheet of waterproofing has been constructed about it. This consists, as a rule, of a 4-inch course of concrete laid below the regular invert and covered with a layer of asphalt meeting a similar layer applied over a coating of Portland cement mortar on the side walls, the asphalt being in places continued over the roof. Where steel was used in the construction additional precautions were taken by running a vertical course of ribbed tile against the asphalt on the side walls and outside of it a course of brick masonry covered again with asphalt. The ribbed tile was connected every 6 feet by a vitrified pipe, with the drains within the subway.

The construction under the streets was carried out so far as possible by what has been termed the slice method. In this trenches about 12 feet wide were excavated across the street to as great a distance and depth as was necessary for the construction of the subway. The top of each such excavation was bridged by strong beams and timbering, the upper surface roofed with plank flush with the street level, and kept covered during the daylight hours in such a way as not to cut off street traffic. In each such trench or excavation a portion or slice of the subway was constructed, and in due time properly joined to the contiguous slices. This method was so used as not to disturb the street railway tracks at all, and when necessary the whole surface of the street was in the daytime entirely in service, carrying its normal traffic.

In one part of the subway even the opening of the surface at night was avoided by the use of a hydraulically driven roof shield. In this section there was first driven a tunnel on each side of the street, in which were built the side walls of the subway. The course of the construction in this case is shown by the sections given in the upper part of the right-hand page of the supplement. No. 1 shows the street with the tunnel drifts in for the side walls; No. 2, with part of the waterproofing and concrete in place, and No. 3 with the hydraulic shield in location. The shield differed from those usually employed in that it did not embrace the whole cross-section of the tunnel, but only that of the arch, and was supported on the side walls built ahead of it in the tunnel drifts, as shown in section No. 1. The track for the shield to slide upon was imbedded in the top of the side walls. The shield was driven by ten 6-inch hydraulic jacks, in which a maximum pressure of 3000 pounds per square inch was used. The weight of the machine was about 22 tons, and it was calculated to sustain an approximate load of 640,000 pounds.

Curve on the Four-Track Line.



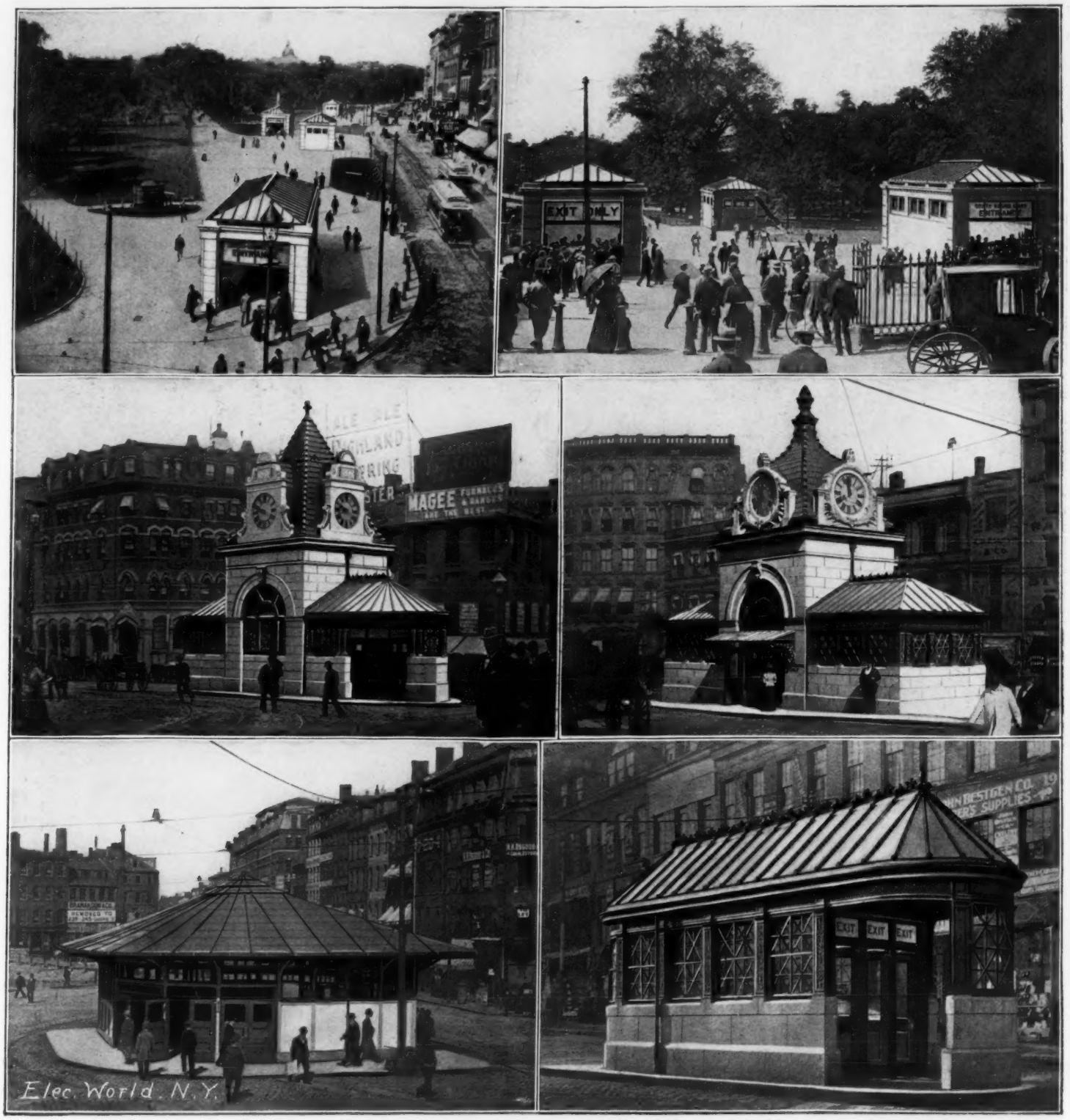
The Portal in the Public Gardens.

A cut-and-cover method was used on Washington Street, where the proximity to the surface and the combined steel and masonry type of subway construction precluded the use of a shield. The different stages of the construction are shown in the central group of cross-sections on the second page of the supplement. A narrow and short length of trench was dug at night on each side of the street and bridged over before morning, as shown in section No. 1. Short lengths of the side-walls in the subway were built in these side trenches, as shown in section No. 2. At night a portion of the surface between the two side walls was removed and transverse roof beams placed and the wooden bridging put across before morning, leaving the structure as shown in No. 3. The subsequent operations, such as building the roof, removing the remainder of the earth and constructing an invert, were done from underneath. Curved steel side posts were used here to allow room for piping, straight posts and corner braces being the rule.

Through the Common and Public Garden the construction could, of course, be carried on in an open excavation, as it was unnecessary to maintain the surface while the work was going on. An ingenious equipment was here used, consisting of three machines fol-

lowing each other on a track supported about on a level with the original surface. The most advanced of these machines consisted of two steam derricks with booms about 60 feet long, which hoisted out buckets holding from 30 to 60 cubic feet of earth, and dumped them into cars running on a narrow-gauge track to a dumping-ground. Stone, sand and gravel required for masonry were dumped into a hopper on the top of the second machine, in which they were screened, the stone passed through a crusher and the gravel washed in a tank. In the second machine was also another hopper, which could be filled with cement, the hoppers being arranged with regulating slides by which the proper proportions of the different materials for the concrete masonry—namely, 1 part cement, 2½ parts sand and 4 parts gravel—could be regulated and delivered to the revolving concrete mixer underneath. The third machine consisted of derricks used to put the concrete in place and to set the footing stones and steel work.

The stations are remarkably attractive structures and well adapted to their duties. The illustrations on this page show the exteriors of six of them. The staircase coverings of those in the four upper illustrations are of classic design, with walls of granite and roofs of glass. The interior walls are faced with white enamelled brick, the rest of the subway having a finish of a white lime wash. Island platforms of artificial stone have been used in the four-track part of the work, and connected where necessary to sub-subways, by which passengers may transfer. The platform levels are, as a rule, one foot above the rail-heads.



THE STAIRWAY COVERINGS ON THE TREMONT STREET MALL.
THE BUILDINGS OVER STAIRWAYS ON SCOLLAY SQUARE AND ADAMS SQUARE.
THE STAIRWAY BUILDINGS AT HAYMARKET SQUARE AND NORTHERLY END OF SCOLLAY SQUARE.

Between the roofs of those stations under the streets and the pavements above a 3-inch stratum of tar, concrete and a 2-inch layer of sand are interposed in order to deaden the noise and vibration.

The subway was leased to the West End Street Railway Company, and is now used by its successor, the Boston Elevated Rail-

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way Company, the term of the grant being twenty years, the compensation to be 4⅞ per cent. of the net cost of the subway, or not less than a toll of 5 cents for each passage through the subway of a car. The company supplies its own power, lights the subway and maintains it in good condition. The compensation is sufficient to meet the annual interest and the sinking fund requirements of the forty-year bonds which have been issued by the city for the construction of the subway. The bonds were sold at such premiums as to make the average rate of interest less than 3½ per cent.

Views of the Interior of the Park Street Station, Showing Loop and Car Pits.
The Adams Square and Scollay Square Stations.
The Haymarket Square and Boylston Street Stations.

Work was begun on the subway on March 28, 1895, the official date of completion being August 15, 1898, covering a period of three years, four months and eighteen days. During this time all streets under which the subway runs were opened for traffic between 8 o'clock in the forenoon and 6 o'clock in the afternoon, as required by legislative enactment. The work was carried on nights and Sundays. The limit of expenditure fixed by the Legislature was $7,000,000. The estimated cost made before the work was begun, exclusive of land damages and corrected for change of plans, was approximately $3,992,000. The total cost, exclusive of additions authorized in 1897, including ventilating and pump chambers, changes of pipes and sewers, administration, engineering, interest on bonds, etc., has amounted to about $3,700,000, showing a very close agreement with the estimates. Of this amount $142,000 was spent on pipe relocations. The total fatal casualties were five workmen killed and ten deaths due to the explosion of gas on March 4, 1897.

The traffic for the year ending September 1, 1898, amounted to approximately 15,000,000 passengers. Less than one-half of the subway was in use during that year, and not all the surface lines for that half had been transferred to it.

The work of equipping the subway with the necessary apparatus for its operation has been done by the Boston Elevated Railway Company.

The rails used are the standard of the American Society of Civil Engineers for steam railroads, and weigh 85 pounds to the yard. Each rail is protected for its entire length by a rolled steel guard of special section, weighing 43 pounds to the yard, which is securely bolted to the running rail. The joints are of the continuous pattern, giving a base support to the rails. Rolled steel tie-plates are used on each tie. The ties are of oak or chestnut, thoroughly treated with woodiline to exclude moisture, thereby insuring proper insulation, and also increasing their durability. Ties are laid in broken stone ballast.

The switches and frogs are of special design. The switches are arranged to be thrown by levers, fastened in place by steel wedges. At the northern outlet of the subway, where the cars are obliged to cross from one track to the other, a switch tower has been erected, and the four switches at this point are controlled by means of levers from the tower.

An inverted wooden trough, made of kiln-dried cypress lumber, is securely fastened to the iron work of the roof structure, and special car-barn hangers are set flush into this trough. Sheets of rubber about one-quarter of an inch thick are placed both between the trough and ironwork, and between the hanger and trough, for the purpose of deadening the noise as much as possible. The insulating bolt, carrying a specially designed mechanical clip, supports the trolley wire, which is also of special design, being in shape like a figure 8, and having a capacity of about 362,000 circuilar mils.

These hangers are placed about 12 feet apart on straight track, and as close, in places, as 3 feet apart on curves, making the construction at once very rigid, simple and workmanlike.

The trolley wire in the subway is separated by insulating joints from the overhead work outside, and in addition, it is divided into two sections at Park Street, these sections being fed by separate cables. Conduits for feeders have ben built on each side of the subway, the ducts being composed of cement-lined iron pipe laid in concrete; some terra-cotta conduit has also been laid. The ducts are covered over with a smooth layer of cement, which serves as a walk at each side of the subway.

A new underground conduit of fourteen ducts has been built from the central power station to the Pleasant Street entrance of the subway, a distance of 3500 feet; and the cables in general use for feeding the subway have been installed in this conduit. In addition connections have been made with the main underground trunk line feeder system from the central power station to Adams Square, by means of branch conduits entering the subway at various points; also connection with the East Cambridge, Charlestown, and Harvard power stations is had by means of underground conduits entering at Scollay Square and Causeway Street.

By means of switches in connection with the various feeders and cables, not only can the cars in the subway be supplied with power by means of the cables designed for that purpose, but if anything should happen to these cables, switches can be closed, so that the cables that ordinarily supply the downtown surface lines can, by increasing the load on them to a slight extent, be used to feed the subway as well, or the subway can be fed in part from East Cambridge or other power stations. On the other hand, if it should be necessary, the subway cables can be used to help out the downtown surface lines.

In the subway itself the rails are used for the return circuit, being bonded at each joint with two 4/0 solid bonds, and the rails of all the tracks are tied together by a 500,000 circular mil jumper every five or six hundred feet. At the Pleasant Street entrance a return of the rails, consisting of cables with a combined capacity of 2,500,000 circular mils, is run to the central power station, while at all entrances the track is connected to the outside return system.

The following table gives some of the material used in equipping the overhead lines of the subway:

Trough construction for trolley wire	23,625	feet.
Figure 8 trolley wire	23,362	"
1/0 and 2/0 trolley wire at entrances and loops	7,055	"
Barn-hangers and insulating bolts	3,093	"
Insulating joints	17	"
Feeder switches	35	"
Ground return, 500,000 cm cable, about	5,000	"
Number of feet of ducts in conduit in subway, alone, about	81,905	
Manholes	63	

Electricity was adopted as being the safest and best method for lighting the subway, incandescent lamps being used between stations, and both incandescent and arc lamps at the stations.

The incandescent lamps are wired on the series-multiple system, the lamps being arranged in series of five, each series connected between the positive and negative lead wires. The voltage used is that of the regular railway circuit, or about 500 volts, each lamp therefore taking about 100 volts, although lamps of lower voltage are used near the ends of the lines on account of the drop in voltage due to the resistance of the circuit. A portion of the arc lamps are also connected in series of five across the lead wires and supplied with current of 500 volts' pressure. They are of the enclosed-arc type, and only require trimming once every 150 hours, and are connected with resistance coils so that in case a lamp should cease to burn the resistance is connected into the circuit and the lamp cut out so that the remaining four lamps on that individual circuit will continue to burn as before. The remainder of the arc lamps are high-potential or series enclosed arcs, burning 150 hours without retrimming, the current being furnished by the Boston Electric Light Company. The current for the incandescent and the first-mentioned portion of the arc lamps is furnished from the power stations of the Boston Elevated Railway Company, cables of 500,000 circular mils capacity being run from the central power station, and cables of 500,000 circular mils capacity from the Dorchester power station. These latter cables are provided with a connection at central power station, so that they can be supplied from that station in case anything should happen to Dorchester.

In addition, the various stations of the Boston Elevated Railway Company, seven in number, are connected together (with the exception of East Boston) so that any station could be helped out by the others; and this gives extra precaution for continuity of light. In addition to the above a connection with the 500-volt circuit of the Boston Electric Lighting Company is provided at the switchboard in the subway, and by means of a double-throw switch all of the load carried by the central power station can be transferred to the Boston Electric Light Company's system; and this is done each day to be sure that everything is in good working order.

It will thus be seen that four independent sources of light supply, besides the lights in the cars, are provided and in regular use, besides the opportunity to use the other power stations, and it is therefore almost impossible that all of these sources should fail at the same time and leave the entire subway in darkness. The incandescent lamps are arranged in lines on each side of the subway, and a circuit is also run betwen the tracks, this latter being the one supplied from the Dorchester power station. The lamps from any one circuit are about 36 feet apart, but the various circuits are staggered in such a way that in the two-track sections the individual lights are only 12 feet apart, and in the four-track sections only 6 feet apart, running lengthwise of the subway, and therefore if any series of the five lights gives out it only means the loss of every third or sixth lamp out of a length of fifteen or thirty lamps, according to the location, until the matter is attended to. At present there are installed in the entire length of the subway about 1,235 incandescent lamps. At the stations the incandescent lamps on the side walls are retained, but the most of the light is obtained from the arc lamps, there being 136 of the enclosed arcs furnished from the 500-volt circuit and thirty-nine enclosed arcs on the circuit of the Boston Electric Lighting Company. These lamps are wired in such a way that during the daytime, when considerable daylight penetrates into the stations, every other lamp can be cut out.

At the corner of Tremont and Boylston Streets, over the subsubway, a room about 24 feet by 17 feet is occupied as a centre of distribution for the electric system. Here is located a marbleized slate switchboard, consisting of three panels, on which are mounted three circuit breakers of 100 to 500 ampere capacity, two Weston ammeters of 0.250 and 0.200 ampere capacity, and six double-pole, double-throw switches. The circuit breakers are connected to the positive cables from the central power station, Dorchester power station and the 500-volt circuit of the Boston Electric Light Company.

In addition, on the back of the board there are three more circuit breakers connected to the negative side of the above mentioned circuits. Wattmeters are also provided upon the various circuits, so that the exact amount of power used can be determined. The wires from all the various branch circuits are connected to the various switches, so that the lights can be controlled from this point. The

necessary fuses and circuit breakers are provided for each circuit. The current at 500 volts' pressure, supplied from the central power station, varies from about 130 amperes to 180 or 190 amperes, and that from Dorchester is about 40 amperes. This room is provided with a desk for the use of the chief electrician, and is also provided with a work bench, with a vise, tools, etc., so that all small repairs can be made at once.

The electric current is used for many other purposes in the subway besides furnishing power for propelling the cars and lighting, among which may be mentioned running the pumps for draining the subway, fans for ventilation, counters for keeping track of the number of cars entering and leaving the subway, heating the ticket offices and other rooms, and signalling systems of various kinds, including alarm bells, telephone and watch-clock systems.

The pump chambers at Charles Street, Eliot Street, Adams Square, and Haymarket Square have ben wired so that the motors for running the pumps can be run either from the circuit of the Boston Elevated Railway Company or from the circuit of the Boston Electric Light Company.

The method of operation of these pumps is of interest. The water collects in a reservoir below the floor, and when it reaches a certain height it raises a float that is connected by means of a chain with an automatic rheostat that starts one motor direct connected to a vertical submerged centrifugal pump that removes the water. When the water has fallen to a certain height the float descends and stops the motor. If it should happen that the first motor did not start the water on rising a little higher would start the reserve motor, and if that should not work and the water continue to rise an alarm bell at the centre of distribution will ring and give warning that something is wrong. This alarm consists of an independent float connected with a rod that, when it reaches a certain height, completes a circuit and causes a drop to fall at the centre of distribution and close a local circuit that rings a bell until it is stopped.

Duplicate pumps are used at each chamber, and they each have a capacity of about 300 gallons per minute, and are direct connected to 5-hp motors, and thus far have had no trouble in taking care of the water. There is one pump of larger capacity at Eliot Street.

Up to the present time only three sets of fans have been installed in the ventilating chambers, and these are all south of Park Street. One exhaust fan 72 inches in diameter has been put in temporarily at the Boylston Street chamber. This is being run through counter-shafting by an electric motor, the current for the same being taken from the trolley circuit. Two fans, each of 30,000 cubic feet capacity per minute, are being installed in the ventilating chamber between Hollis and Eliot Streets, and two each of 37,000 cubic feet capacity per minute are being installed in the chamber near West Street. The fans are to be operated in pairs, and driven by motors supplied with current from the trolley circuit. The motors are to be direct connected to the fan shafts, and each pair so arranged that they can be run either in series or multiple.

The ticket offices, the centre of distribution room, the switch tower at the northern outlet of the subway, and the emergency rooms are all heated by electric heaters, the power for the same being taken from the trolley circuit. The lights in the ticket offices and clock towers are also supplied from the trolley circuit. A watch clock system with twelve stations located at the various pump rooms, entrances, platforms, etc., has been installed, and thus a record is kept of the location of the watchman, etc.

Each platform is connected by telephone with the company's telephone system, and in addition a system of telephones between stations is being installed so that the station masters can communicate with each other without calling up the central exchange.

On the platform at the foot of the entrance stairways, ticket offices have been constructed of suitable design for carrying on of the passenger traffic, there being twenty-seven in all. These offices, as mentioned above, are lighted with incandescent lights and heated by electric heaters. On the platforms at the foot of the exit stairways are located turnstiles through which exit may be made, but which bar entrance to the platforms. At Adams Square and Haymarket Square the ticket offices and turnstiles are at the top of the stairs in place of the bottom, as at the other places.

Emergency rooms have been built in some of the stations into which any one taken sick or injured can be conveyed and remain until they can be removed. These rooms are equipped with a cot bed, chairs, table, etc., and are heated by electric heaters.

A system of piping for fire service, consisting of 3-inch pipes connected with the city mains, has been run through the subway.

The Rapid Transit Commission was also required to construct a bridge to Charlestown, which will be completed before the term of office of the commission expires on the 2d of July, 1899. It was also authorized to construct another subway to accommodate the travel from Cambridge, but nothing has been done in this direction. A submarine tunnel has also been planned to East Boston, and the commission has prepared several alternative plans and surveyed the routes for this improvement.

The members of the commission are George G. Crocker. Charles H. Dalton, Thomas J. Gargan, George F. Swain and Horace G. Allen. The chief engineer is Howard A. Carson.

The Trend of Central-Station Design.*

BY B. J. ARNOLD.

It is but little over a decade since the electrical student was told by those who were supposed to be authorities that to get a reasonable efficiency in electrical machinery high rotative speed in the moving parts was necessary. While this statement contains an element of truth, it is by no means as important as at first supposed, for our slow-speed generators and motors of to-day are more efficient than many of the high-speed machines of that time. Difficulties in the manufacture of heavy electrical machinery and lack of knowledge on the part of the designers of that time were probably the father of the idea; but, be that as it may, the result was to flood the country with electrical plants, consisting of engines, dynamos, pulleys, shafting and belts—good, bad, and indifferent—thrown together in almost any manner. These, however, performed their functions remarkably well under the circumstances, and enabled the youngest branch of the engineering industry to command the brains, energy and capacity necessary to revolutionize the transportation and factory methods of our cities and make herself felt in many of the homes of our smaller cities and towns. But since Darwin's law of "the survival of the fittest" applies equally well in engineering as in natural history, the belts and pulleys are gradually becoming extinct; the engines and generators have left off their prehistoric ear-marks and have grown to their responsibilities and to the possession of those elements which make them the bulwarks of electrical industries, the same as the older types of steam engines were to the factories which they drove prior to the advent of electrical transmission. To determine how far this development has gone and its probable tendency in the future is the subject assigned me by your committee to discuss to-day.

The problem which confronts the power-station designer is almost invariably that of the operation of arc lamps, incandescent lamps and motors for various purposes with the greatest degree of economy and with as little expenditure in first cost of plant as possible. This is strictly true of combined lighting and power stations, which present the most difficult cases to handle. When, however, the problem is simply one of the development of electrical energy for power purposes only, such as railway work or transmission work, it becomes much simplified. Since the question of the design of a station is interlinked with and dependent upon the system of distribution adopted, we find ourselves struggling with many of the old questions and some new ones, such as the alternating arc versus the series arc and the constant-potential arc; the polyphase transmission plant versus the direct current; the advisable voltage, either alternating or direct, to adopt for central station work.

While I do not in this paper presume to settle these questions, we must necessarily form some idea of their probable solution for general cases, for otherwise we can hardly expect to speculate on "The Trend of Central-Station Design." The old belted station we may consider obsolete, and come at once to the general types which have been recently installed by competent engineers, and which may be considered as embodying the latest ideas of those skilled in this class of work. In all of these stations we find certain main parts which may be considered as accepted practice, as follows:

Of course, there are many belted stations running and doing excellent service, which simply speaks well for the engineers and designers, and more especially the manufacturing companies who installed them in the earlier days, because at that time there were few

*Abstract of address presented to the Northwestern Electrical Association, Milwaukee, January, 1899.

engineers skilled in this branch of work, except those in the employ of the manufacturers.

The points in accepted practice are, then:

Water-tube boilers, capable of carrying high steam pressures. This probably will be disputed somewhat by the advocates of other types of boilers, and with some reason; but it nevertheless has become almost standard to use water-tube boilers in modern central stations.

Mechanical stokers, or improved furnaces or grates.

Self-supporting brick or steel stacks, usually steel. A steel stack can be put up for considerably less money than a brick stack, and for all practical purposes it is equally good, and can be maintained a sufficient number of years to warrant its adoption in almost every case if properly looked after.

High-pressure steam piping is not duplicated, as was thought necessary by engineers eight or ten years ago—practice having proven that one single steam header can be divided so as to make a plant reliable if the engines are properly located with reference to the boilers and the header. I planned one plant in 1891 with a duplicate system of steam piping, and I firmly believed in it at that time, but have never since had occasion to use the duplicate system, and have never since installed one. I think there are few engineers in the country to-day putting in plants with duplicate systems of piping, unless in buildings where it seems necessary to do it, and on account of the peculiar location of the engines with reference to the boilers. Steam pipings costs excessively in a power station, and the less of it put in the better, because there is then less radiating surface to waste heat and fewer parts to keep up. The diameters of the steam headers which are being placed nowadays are somewhat decreased as compared with those installed four or five years ago.

Large compound condensing steam units. It has become accepted practice to install as large engines as are practical on account of the decreased cost per horse-power and the increased economy of a large engine over a small one. They are almost invariably compound engines, where it is possible to condense, and in many cases whether it is possible to condense or not. The tendency toward triple-expansion work is not as strong as it was five years ago, it having been determined that for almost all cases a compound engine will get nearly as good economy as a triple-expansion engine, and in many cases just as good; requires less investment, is less costly to maintain, and the difference in economy of the triple-expansion over the compound is so slight that it makes it inadvisable to install except in exceptionally large sizes. On account of the excessive diameters of the low-pressure steam cylinders in large compound engines it is the practice to install triple-cylinder compound engines—that is, to divide the low-pressure cylinder into two smaller cylinders, the combined area of the two being equal to the area of the large cylinder of a single compound engine.

Direct-connected generators of large capacity. What has been said in general regarding large steam units applies equally well to electrical generators, because the larger the size the greater is the economy of the combined unit.

To these chief features of design, which have become so generally accepted as to require little or no discussion, there may be added several features which may be justly called "tendencies" or "trends," which have not yet been universally adopted.

Under the first heading comes economizers. Economizers, as you are aware, consist of a series of vertical cast-iron tubes carrying water within them, and around the outside of which the gases pass from the boilers to the smoke-stack. There is no doubt, in my judgment, but that there is economy in the use of an economizer, ranging from 5 to 7 or 8, and sometimes as high as 10 per cent. In order to get the benefit of an economizer, ample draught must be provided. Sometimes an economizer is installed where the draught is poor, the result being no economy and the annihilation of the draught. There is only one solution for this, and that is to increase the height of the stack or introduce mechanical draught to realize the benefits of the economizer.

Mechanical draught. Under this head there are two types, induced draught and forced draught. Induced draught apparatus consists of a large fan or fans driven by steam engines or electric motors, and placed between the economizers and the smoke-stack, or, if economizers are not used, between the boiler flues and the smoke-stack, the object being to draw or suck the smoke from the boilers through the fan and deliver it into the stack. The advantages of either type of mechanical-draught schemes are, first, a lower and less expensive stack can be used. In fact, no stack at all is required except to get the gases above the buildings in the immediate neighborhood of the property. Second, the fires can be handled under any and all conditions. We are all aware that the condition of the atmosphere changes our draught, and in case a stack is no larger than is required, there are days when it is difficult to hold steam, and it becomes necessary to put more boilers into service than would be necessary if a mechanical-draught fan were used. Where the economizers can be installed in connection with induced draught an economy is always effected.

Then there is the forced draught, which consists in blowing air under the grates of the boiler and forcing it up through the fire and into the stack, which is supposed to perform the same function that the induced draught does. The objections to it are that inasmuch as it creates pressure in the fire-box, the gases are liable to escape out into the room and make a distasteful fire room. Otherwise the results accomplished are practically the same as with forced draught, and it is considerably less expensive to install, and this is its chief advantage.

Cooling devices. Under this head come cooling towers and cooling tables. In most plants in this country there are probably no facilities or natural opportunities for getting water for condensing purposes, and until recently we have thought it was advisable to continue to operate these plants non-condensing. During the past two years there has been a tendency to put in these cooling towers, and when properly put in there is always an economy effected, resulting in a net saving of at least 15 per cent. in fuel. A tower consists of a series of vertical tubes or sheets, usually within a wrought-iron frame, through which air is forced by blowers, driven by steam engines or electric motors, and down through which flows, or sprinkles, or is spread, the water delivered from the condensers. The water coming in contact with the air is cooled and accumulates at the bottom of the tower, and is then pumped into contact with the steam and condenses it. The same water is used over and over, so that only from 5 to 10 per cent. will have to be renewed on account of the evaporation. The 5 per cent. must be added from the city waterworks, or other outside source.

In place of the cooling tower, where real estate is cheap and available, a table can be erected, consisting of a series of boards laid gridiron shape, upon which the water is delivered by the condenser pumps and is sprinkled down through the boards, and the air from the atmosphere penetrating through underneath the shelves comes in contact with the hot water and cools it. It then forms a pool at the base of the shelves and is taken from there and pumped back in contact with the steam in the same manner as in the cooling tower. This device can be installed for the same, or less, amount than a cooling tower, and it is advisable to install it where there is sufficient real estate to place it upon, because it requires no power to cool the water, and power is required to drive the fan of a cooling tower.

Motor-driven auxiliaries. Many of the most modern plants are equipped with electrically driven air pumps, boiler-feed pumps, and cooling-tower motors, if tower is used. There is a question as to whether this is the most economical thing to do or not. Some believe it to be so. Others maintain that the latent heat derived from the exhaust from the steam cylinders of the steam-driven auxiliaries, if run through a surface or closed heater, more than compensates for the wasteful use of the steam by these steam pumps. I incline toward the belief that there is economy in the use of electrically driven auxiliaries, on account of the non-wasting of heat by pipe radiation, if for no other reason, because the primary objects to be obtained in a power station are to generate the steam with as little fuel as possible, lead it as directly as possible to the steam cylinders, where it is to do its work, and exhaust it into the vacuum as quickly, with as little pipe to radiate heat as possible; and electrically driven auxiliaries seem to me to accomplish this result better than any other.

We now come to what is at present known as the combination generator. It consists of a machine having two commutators and capable of generating current at two voltages. It may be direct current on each end or alternating current on one end and direct on the other; but, in either case, it is a machine deriving its power from an external source in contradistinction to a rotary converter, which revolves itself by means of the current passing through it. These machines are coming into use for railway work, telegraphy, and printing-office work. They seem to be the connecting link between the alternating and direct-current apparatus. A power station installed with such machines is capable of generating polyphase currents and transmitting such current by means of static transformers to a long

distance at a high potential, then running through rotary converters and delivering out on the line direct current, thus enabling us to utilize our direct-current motors which are already installed. The efficiency of such a machine is from 92 to 98 per cent., dependent upon its size.

There is one type of machine whose future has not as yet been determined, and perhaps no man can at present safely foretell its future, but there seems to be a demand for it. I refer to the multi-circuit arc dynamo. There is such a machine made to deliver current for four circuits of about 100 lights each, and if the series arc is to survive, this type, made to deliver current for five to ten 100-light circuits, will be the arc machine of the future, and it will revolve at the same rate of speed as our present direct-connected incandescent or alternating machines do, because we must eliminate belts. I am speaking of large stations, and, as I say, if the series arc is to survive it will be driven by large machines with slow rotative speeds. Such a machine will probably not have an efficiency greater than from 80 to 82 per cent., and that is what militates against it, the same as the low efficiency of the present series-arc machine does.

Having thus enumerated somewhat briefly the principal factors which are working to shape the design of the future central station, I will briefly describe two types of stations which have lately been built, and seem to represent the latest practice.

1. The composite station, consisting of two or more independent steam units carrying upon the engine shaft a direct-connected generator suitable for giving light or power, and in addition a pulley or fly-wheel carrying a belt or rope driving onto a common shaft to which the other engines similarly drive, and from which small direct-current arc machines, or other old-style machines, derive their power. This type is admirably adapted for utilizing out-of-date machinery. There have been several large plants of this style installed in the last two or three years by a leading firm of engineers, and the stations, I understand, are giving excellent satisfaction. I refer particularly to the stations at Toledo and Washington, and the solutions of the particular conditions of those cases seem happy ones, because they enable the owners of the properties to utilize all of their old machinery until such times as it may be deemed advisable to change.

2. Consists of independent engines carrying direct-connected generators. This type is admirably adapted for plants where but one kind of current is delivered, but in case two kinds are required it becomes necessary to have a generator of each type upon each engine shaft, or have double the number of reserves units that would be required if but one kind of current were desired from the plant. In either case, the investment in plant becomes excessive to insure reliability. Two or more kinds of current can be obtained from such a plant by making all of the generating units alike, so far as kind of current is concerned, and driving secondary generators by means of motors running from the main generators. This means is often adopted in rebuilding old plants for driving the old series-arc machines, being directly coupled to an alternating or direct-current motor driven from the main bus bars. While the stations I mentioned a few moments ago are good engineering, I believe this is better engineering—that is, to eliminate belts entirely—and if we have a number of different types of machines to drive, we had better produce our energy from standard machines of the same character and size, if possible; then drive the older type of high-speed machine directly connected from motors, and the efficiency of the combined plant will, I believe, be better than where the belted type is used.

3. There is one other method of construction, which I will not class as accepted, but mention it as a tendency in power-station design, known as the Arnold system. There have been several of the plants installed, in which the generators are carried on independent bearings, and all made available from more than one engine, but as I do not wish to take advantage of you, I will refrain from discussing the merits or demerits of this system. It is claimed by its advocates to have certain advantages.

No Indemnity for the Cutting of the Philippines Cable.

The British Eastern Australasia & China Telegraph Company filed a claim with the State Department of the United States for $36,000 damages for the cutting of its cable by Admiral Dewey at Manila last May. The United States Attorney-General has rendered a decision, finding that under the law of nations there is no ground for a claim for indemnity, where a military commander cuts a cable within the territorial waters of an enemy.

Odd Experiences with the Niagara Falls and Buffalo Transmission Line.

A number of times during the past four months there have been short circuits on the overhead line between Niagara Falls and Buffalo, which have made it necessary to shut off power for a few minutes, and, in one case, for several hours.

In several cases the conductors were burned through, so that one of the two circuits had to be cut out until repaired. The reason for the trouble has been a source of perplexity to those in charge of the line, as the real cause has only recently been located. Last autumn a guard wire broke and one end fell over the line wires, making an intermittent cross as it swung in the wind. This started an arc between two parallel wires, with a potential difference of about 11,000 volts, which was blown by the wind for several hundred feet along the line before it broke. It was a pretty exhibition of fireworks, and some boys who saw it wanted to see more. So at convenient times, when no one else was about, they threw miscellaneous pieces of wire, barrel hoops, etc., on the wires and watched the fun. Generally the arcs would break before any great damage was done to the line, but it was hard on the switches and circuit breakers. During the past week three of the young men have been caught, and the line is being closely watched to prevent any more such mischief. At the Niagara Falls end arrangements have been made by which, when the circuit breakers are thrown by a short circuit on the line, the wires may be connected to a set of lower potential buses, on which the short circuit may be burned off, without danger of establishing an arc that will be maintained across the gap between the line wires.

Curiously enough, the worst short circuit was caused by a large stick of wood, which was thrown upon the wires, and allowed a small current to pass, which, with the high e. m. f., generated enough heat in the wood to carbonize it and start an arc, which burned one line wire in two. The same effect was observed, with less serious consequences, when a small branch from a tree near the line, which was being felled to remove a possible danger in the next gale, flew upon the wires and started an arc, which traveled before the wind about 300 feet along the line. One reason that the cause of the trouble of the past four months was so long hidden is that the comparatively small wires, hoops, etc., that were thrown on the line were nearly, if not quite, destroyed by the current.

Telegraphing Without Line Wires.

To the Editor of The Electrical World:

In The Electrical World of January 14 last the article "Telegraphing Without Line Wires," by William Bissing, very strangely takes no notice of the fact that Prof. S. F. B. Morse was the first on record to transmit telegraph signals without wires between the points at which the signals were made and recorded, and that twelve years prior to the English patent of Lindsay, Morse accomplished the feat, and the account was published in Alfred Vail's book on the "American Electro Magnetic Telegraph" in 1845. As this publication was nine years prior to the date of Mr. Lindsay's patent, No. 1242, of 1854, there seems to be but one of two explanations to account for the oversight of Morse. One is an ignorance of the subject, or otherwise a determination to place credit where it does not belong, as there will not be a doubt in the mind of any unbiased reader that the following from Mr. Vail's book completely describes and embraces the method set forth in Mr. Lindsay's patent:

"MODE OF CROSSING BROAD RIVERS, OR OTHER BODIES OF WATER, WITHOUT WIRES."

"The following extract from Professor Morse's letter to the Secretary of the Treasury, and by him submitted to the House of Representatives, December 23, 1844, in relation to this interesting subject, will sufficiently illustrate it:

" 'In the autumn of 1842, at the request of the American Institute, I undertook to give to the public in New York a demonstration of the practicability of my telegraph by connecting Governor's Island with Castle Garden, a distance of a mile; and for this purpose I laid my wires, properly insulated, beneath the water. I had scarcely begun to operate, and had received but two or three characters, when my intentions were frustrated by the accidental destruction of a part of my conductors by a vessel, which drew them up on her anchor and cut them off. In the moments of mortification I im-

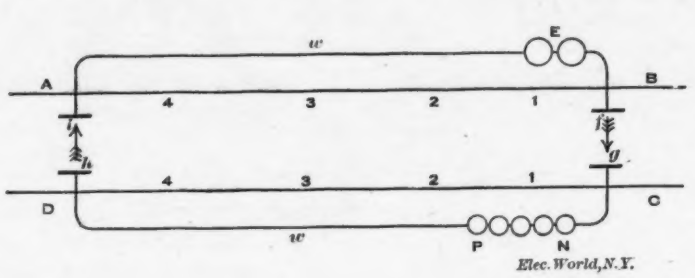
mediately devised a plan for avoiding such an accident in future by so arranging my wires along the banks of the river as to cause the water itself to conduct the electricity across. The experiment, however, was deferred till I arrived in Washington, and on December 16, 1842, I tested my arrangement across the canal, and with success. The simple fact was then ascertained that electricity could be made to cross a river without other conductors than the water itself; but it was not until the last autumn that I had the leisure to make a series of experiments to ascertain the law of its passage. The following diagram will serve to explain the experiment:

"'*A*, *B*, *C* and *D* are the banks of the river; *N* and *P* are the battery; *E* is the electro magnet; *w w* are the wires along the banks, connecting with copper plates *f*, *g*, *h* and *i*, which are placed in the water. When this arrangement is complete, the electricity, generated by the battery, passes from the positive pole *P* to the plate *h*, across the river through the water to plate *i*, and thence around the coil of the magnet *E*, to plate *f*, across the river again to plate *g*, and thence to the other pole of the battery *N*. The numbers 1, 2, 3, 4, indicate the distance along the bank measured by the number of times of the distance across the river.

"The distance across the canal is 80 feet. On August 24 the following were the results of the experiment:

No. of the experiment.	1st.	2d.	3d.	4th.	5th.	6th.
No. of cups in battery...	14	14	14	7	7	7
Length of conductors, *w*, *w*.....	400	400	400	400	300	200
Degrees of motion of galvanometer.....	32 and 24	13½ and 4½	1 and 1	24 and 13	29 and 21	21½ and 15
Size of the copper plates *f*, *g*, *h*, *i*	5 x 2⅜ ft	16 x 13 in.	6 x 5in.	5 x 2½ ft.	5 x 2½ ft.	5 x 2½ ft.

"'Showing that electricity crosses the river, and in quantity in proportion to the size of the plates in the water. The distance of the plates on the same side of the river from each other also affects the result. Having ascertained the general fact, I was desirous of discovering the best practical distance at which to place my copper



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plates, and not having the leisure myself I requested my friend Prof. Gale to make the experiments for me.

"'As the result of these experiments, it would seem that there may be situations in which the arrangements I have made for passing electricity across the rivers may be useful, although experience alone can determine whether lofty spars, on which the wires may be suspended, erected in the rivers, may not be deemed the most practical. The experiments made were but for a short distance, in which, however, the principle was fully proved to be correct. It has been applied under the direction of my able assistant, Messrs. Vail and Rogers, across the Susquehanna River, at Havre-de-Grace, with complete success, a distance of nearly a mile.'"

As to the second method described by Mr. Bissing, no mention is made of well-known experiments that were made by Elisha Gray in the Western Electric Company's works, on Kinzie Street, Chicago, in the early part of 1877. Around the ceiling of the factory a metallic wire was erected, with a few cells of battery and a Morse key inserted therein, and in a distant room, entirely removed from the sound of the key, signals made by the key were readily distinguished by the use of a Bell telephone receiver, which responded entirely to the Morse impulses, through magnetic induction.

I am aware that neither Prof. Morse nor Prof. Gray persevered in their experiments to the point where anything resulted that was commercially valuable, and I believe that the same is true of Mr. Lindsay, who is put forward as the first inventor of one of these methods, and I am therefore at a loss to know why mention has not been made of the pioneers who blazed a way through what was then an unknown electrical forest, through which Mr. Lindsay, Mr. Preece, Dr. Lodge and others have since been making extensive and highly interesting explorations.

F. W. JONES.

Alternating-Current Machinery.

BY EDWIN J. HOUSTON AND A. E. KENELLY.

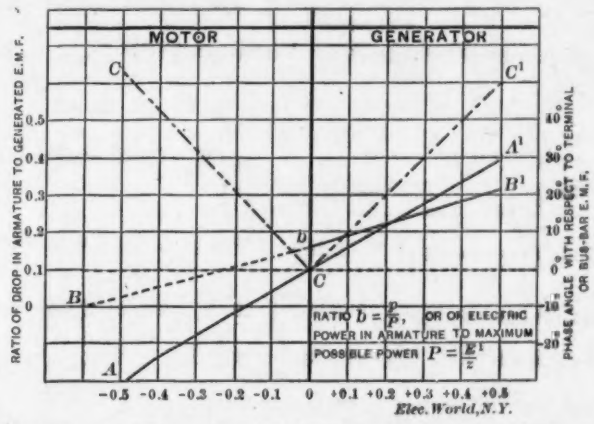
CHAPTER XXVIII.

SINGLE-PHASE GENERATORS AND MOTORS.

The behavior of a single-phase alternator excited to the same constant effective voltage as the pair of bus bars with which it is connected in synchronism is represented in Fig. 160. The apparent impedance of the armature is supposed to be constant, and to have an angle of 84° 15', corresponding to a cosine of 0.1, so that the apparent impedance of the armature is ten times its resistance. In other words, the apparent impedance factor of the armature is 10. The conditions represented are, however, practically the same for any impedance factor greater than 5; i. e., for any impedance angle β, between cos $\beta = 0.2$ and cos $\beta = 0$. Consequently the diagram may be taken to fairly represent conditions of most practical alternators running in parallel with constant potential mains. The abscissas represent the fraction $b = p/P$, or ratio of the power in the armature to the maximum possible power; or, $b = \frac{|EI|}{E^2/Z}$. This ratio is usually between 0.3 and 0.5 at full load, so that we may consider that the range of abscissas from 0 to 0.4 represents the range of load in an ordinary alternator.

The curve ACA^1 represents the phase displacement of the armature e. m. f. relatively to the pressure at bus-bars, or pressure at terminals. Thus at no load or $b = 0$, the armature e. m. f. is in phase with the bus-bars; or, $\alpha = 0$, while at $b = 0.4$ or, approximately, full generator load, the armature e. m. f. leads the bus bars by about 23° or $\alpha = 23°$. Similarly, when $b = -0.4$, or approximately full motor load, the armature e. m. f. lags behind the bus-bar pressure by about 20°.

It is this phase adjustment of the armature e. m. f. which regulates the power taken or given by the machine. In the case of a



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A C A^1 Phase-Angle of Armature E. M. F. in Degrees with Respect to Bus-Bar E. M. F.
B b B^1 Phase-Angle of Armature Current in Degrees with Respect to Bus-Bar E. M. F.
C C C^1 Ratio of Drop in Armature to Terminal or Generated E. M. F.

FIG. 160.—DIAGRAM SHOWING THE RELATION BETWEEN CURRENT AND PHASE IN AN ALTERNATOR RUNNING AS A GENERATOR OR MOTOR IN SYNCHRONISM WITH BUS BARS FOR THE CONDITION $E = e$ OR EQUALITY BETWEEN GENERATED AND TERMINAL E. M. F., WITH ARMATURE IMPEDANCE FACTOR OF 10 OR $\beta = 84° 15'$ OR Cos $\beta = 0.1$.

bipolar alternator, the relative displacement of the armature would be the same as α; so that at full load the armature would be advanced or retarded about 23° with respect to the position occupied at no load, but with n pairs of poles the angular displacement of the armature would be α/n, so that an alternator armature of 10 poles would only displace itself at full load about 5° in advance or retard its position of synchronous running at no load.

The line bB^1 represents the armature current phase at different loads with respect to the bus-bar e. m. f. Thus, at no load, the current leads the bus-bar pressure by about 6°, and at full load the current leads by about 18°. The dotted line bB represents the conditions when the machine operates as a motor, except that, since the armature current is now reversed in direction, 180° must be added. Thus, at about full motor load the armature current leads the bus-bar pressure by approximately $180° - 7° = 173°$. The line bB corresponds to what is shown for the motor current lag in Fig. 159.

The double line CCC^1 represents the current strength in the armature on different loads as the ratio of the drop in the armature impedance to the generated e. m. f. Thus, at no load, there is no drop and no current in the armature, assuming no friction; while, at full generator load, the drop is about 40 per cent. of the generated e. m. f., either as generator or motor, the drop being slightly greater at a given motor load than at the same generator load. Thus, if the machine has an apparent impedance of 10 ohms and a generated e. m. f. of 1000 volts, the drop in the armature would be about 400 volts at full load, representing a current strength of 40 amperes.

It is theoretically possible for a single-phase alternator to run in synchronism with the bus bars at two different phase angles, not only when operating as a generator but also when operating as a motor. The first phase is that already indicated in the figure. The second phase would entail a much greater current strength under practical conditions, and does not present itself in practical service.

We have hitherto assumed that the e. m. f. of the alternator was the same as that of the bus bars with which it was connected. We may now remove this restriction and examine the effects of changing the excitation so as to increase or diminish the generated e. m. f., and we may represent the ratio E/e of generated to bus bar e. m. f., by the symbol k. Let us first assume that E is greater than e, or k greater than unity, as the result of over-excitation of the alternator field, so that $e = 1000$ volts and $E = 1250$ volts, with an armature apparent impedance of $Z = 1 + j9.95 = 10\,/84^\circ\,15'$ ohms. It will be evident that under these conditions if the alternator be running as a motor in synchronism with the bus bars, so that $\alpha = 0$, as indicated in Fig. 161, there will be a resultant e. m. f. of 1250—1000 = 250 volts flowing through the armature in the direction of the generated e. m. f., and, therefore, acting as a generator load. This will at once retard the machine, so that it will lag behind the bus bars. When the lag is 1° 26′ or $\alpha = -1^\circ\,26'$, as shown in Fig. 162, the current in the armature will be $\frac{1250/1^\circ\,26' - 1000}{10/84^\circ\,15'}$ $= 25.16\,/91^\circ\,26'$ amperes, or the resultant e. m. f. will be $oe = 251.6\,/7^\circ\,11'$ volts, and the current $OI = 25.16$ amperes 84° 15′ behind this, or 91° 26′ behind the bus bars; i. e., 90° behind OE. This means that the current OI is a wattless current, in quadrature with the generated current, and neither taking nor giving power to the armature. The current OI will, however, be inclined at an angle 88° 34′ with the direction Ee in which the bus-bar pressure acts, so that the work expended by this pressure will be

$$1000 \times 25.16 \times \cos\ 88^\circ\ 34'$$
$$= 1000 \times 25.16 \times 0.02516 = 633 \text{ watts,}$$

and this will be expended as I^2R in the armature

$$= 25.16 \times 25.16 \times 1 = 633 \text{ watts.}$$

This is on the assumption that the motor has no friction. In practice the friction would constitute a small load and the lag would increase. If, for example, the lag increased to 10°, as represented in Fig. 163, then the resultant pressure on the armature is $1250\,/10^\circ - 1000 = 316\,/43^\circ\,10'$, represented by oe in the figure, and the armature current is $\frac{316/43^\circ\,10'}{10/84^\circ\,15'} = 31.6\,/127^\circ\,25'$ amperes, represented by OI. OI is now in the opposite quadrant to OE, and, therefore, does work upon OE or drives the armature as a motor; while OI is in the same quadrant as Ee, so that the bus-bar pressure does work upon OI or expends the power necessary to drive the motor in addition to the loss by I^2R in the armature.

If the alternator at this excitation be driven by power it will advance its phase beyond the neutral position $\alpha = -1^\circ\,26'$, while if it is allowed to take power, it will fall behind this position.

We may next suppose that E is less than e, and k less than unity. We may, therefore, reduce the excitation of the fields until the generated e. m. f. is, say, $E = 500$ volts. If the machine runs at no load, frictionless, as a motor, it will take the position OE, slightly in advance of the bus bars, or with $\alpha = 2^\circ\ 53'$. The resultant e. m. f. Oe is now $501.3\,/177^\circ\ 08'$, and the armature current $\frac{501.3\,/177^\circ\ 08'}{10\,/84^\circ\ 15'} = 50.13\,/92^\circ.53'$, or 50.13 amperes, 90° ahead of the generated pressure.

If the machine be driven by power, the phase angle α of OE will increase, while, if the machine be allowed to run with load as a motor, OE will fall behind.

We observe, therefore, that if the generator be over-excited relatively to the bus bars, it will run at no load with its phase behind the bus bars, while if it be under-excited it will tend to run at no load slightly ahead of the bus bars. This is shown in Fig. 164, where the dotted line Oe represents standard bus-bar pressure. As the excitation of the frictionless motor is changed, its e. m. f. moves along the circular arc $ABCDF$ being

$OA = 2000\,/5^\circ\ 45'$ volts, $k = 2$
$OB = 1667\,/3^\circ\ 51'$ volts, $k = 1.667$
$OC = 1433\,/2^\circ\ 28'$ volts, $k = 1.433$
$OD = 1000\,/0^\circ$ volts, $k = 1$
$OF = 500\,/2^\circ\ 53'$ volts, $k = 0.5$

In practice, since motors always have friction, and a machine running light is equivalent to a frictionless motor with a load equal to the combined electromagnetic and mechanical friction, the no-load phase will always be slightly behind these positions, particularly at great excitation, since the saturation of the fields increases the hysteresis losses and the consequent magnetic friction.

It is to be observed that when $E = e$ there is no current required to drive a frictionless motor at no load, but when E is greater or less than e, there is always a comparatively strong current in quadrature with the generated e. m. f. In other words, when E differs from e, there is no condition under which the machine will take no current from the bus bars. Moreover, over-exciting the field produces a current lagging behind the generated e. m. f., and leading the direction Ee in which the bus-bar pressure acts, while under-exciting the field produces a current leading the generated e. m. f., and lagging behind the direction Ee, in which the bus-bar pressure acts. Consequently, an over-excited generator running as a motor produces an armature current leading the bus-bar or external pressure, and behaves like a condenser, relatively to the same, while an under-excited motor takes a lagging current relatively to the bus bars, and behaves like a choking coil or reactance relatively to the same. The former will tend to diminish the reactive drop of inductance in the external circuit, while the latter will tend to increase it.

The current strength in the armature under any conditions of load, or $b = p/P$, and under any excitation ratio k is readily found by the following simple geometrical process. In Fig. 165, let it be required to find the current strength which will pass through the armature of the generator of e. m. f. $E = 1000$ volts when connected in synchronism to bus bars of $e = 1000$ volts, or with $k = 1$, and an internal apparent impedance of $z = 10/84^\circ\ 15'$.

Set off the line OA, making an angle $\beta = 84^\circ\ 15'$ with the horizontal line Oe'. Make the length $OA = 100$ units, or representing the maximum current $\frac{1000}{10}$ amperes, which the bus bars could send through the armature impedance. Then, with A as a centre, set off AB at the angle α which the generator e. m. f. makes with the

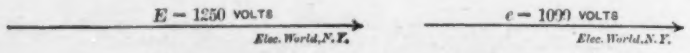

Fig. 161.—Cophase with E Greater Than e.

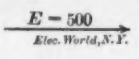

Fig. 163A.—$k = 0.5$.

Motor at No Load and Assumed Frictionless.

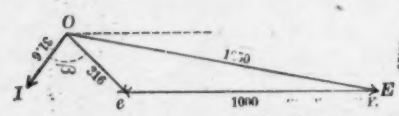

Fig. 162.—$k = 1.25$ No Load.

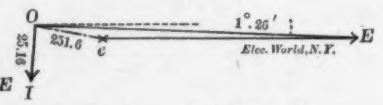

Fig. 163.—$k = 1.25$ Motor Load.

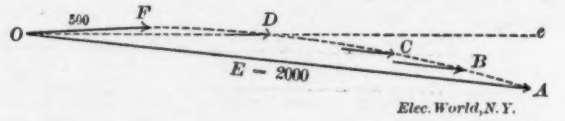

Fig. 164.—Theoretical Phase of Generated E. M. F. for Frictionless Motors at No Load Under Varying Excitation.

bus bars, in this case 20°, and let $AB = 100$ units or the maximum current strength $\frac{E}{Z} = \frac{1000}{10}$ amperes which the generator could send through its own impedance. Then OB will represent, in length, the current through the armature to the same scale, and the angle eOB will represent the phase of this current relatively to the bus-bar pressure. Thus, in Fig. 165, $I = 34.62/15° 45'$ amperes. This

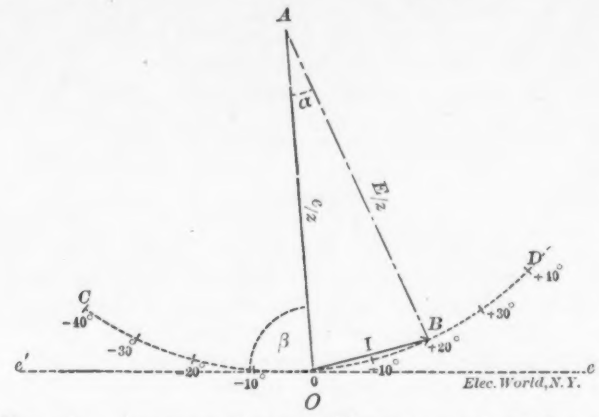

FIG. 165.—ARMATURE CURRENT WHEN $\alpha = 20°$ AND $k = 1$.

agrees with what is shown in Fig. 160. Similarly if $\alpha = +40°$, the current is OD, and with $\alpha = -40°$, the current is OC. In other words, the vector current between full motor load and full generator load traverses the greater part of the circular segment COD.

Fig. 166 shows the corresponding conditions for the case of over-excitation when $k = 1.25$ and $e = 1000$ volts $E = 1250$ volts, $z = 10 /84° 15'$ ohms. Here OA is laid off as before, and the vector AB travels over the circle COD of radius 125 units representing the maximum current $\frac{E}{Z} = \frac{1250}{10} = 125$ amperes. The phase at any given load $b = \frac{p}{P}$ is known from the equation already found.

$$\cos(\alpha + \beta) = k(\cos\beta - b).$$

Set off the angle $\alpha = OAB$ coresponding to the load ratio b in this equation. Then the vector OB represents in magnitude and phase the current strength. It will be seen that when $\alpha = 0$, or at the condition of cophase, the current is $OF = 25 / 84° 15'$ amperes, and the vector current between full motor load and full generator load traverses the greater part of the circular segment CFD.

Fig. 167 represents the same conditions for the case of under-excitation, or when k is less than unity. In this figure $E = 750$ volts, $e = 1000$ volts, $OA = 100$ units $= \frac{e}{z}$ $AB = 75$ units $= \frac{E}{Z}$.

At the same lead of 20° the current is OB, leading the standard

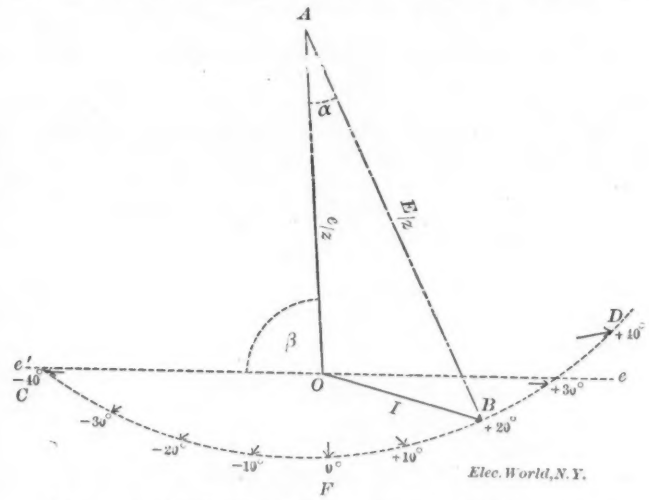

FIG. 166.—ARMATURE CURRENT $\alpha = 20°$ AND $k = 1.25$.

pressure by about 56°. At no load the current is OF, and the vector current runs along the circular segment CFD.

In all cases the external electric power measured at alternator terminals is, $p_e = eI \cos(eOB)$, and the power in the armature $p = EI \cos(\alpha - eOB)$.

The algebraic expression for the current strength as distinguished from the vector expression is

$$I = \frac{E}{Z}\sqrt{b^2 + \left\{\sin\beta - \frac{\sin(\alpha+\beta)}{k}\right\}^2} \text{ amperes,}$$

or substituting for the angle α

$$I = \frac{e}{Z}\sqrt{b^2 k^2 + \left\{k\sin\beta - \sqrt{1 - k^2(\cos\beta - b)^2}\right\}^2} \text{ amperes,}$$

where $b = \frac{p}{P}$, $k = \frac{E}{e}$, and β is the angle of the armature apparent impedance Z. The change in the current strength for different ex-

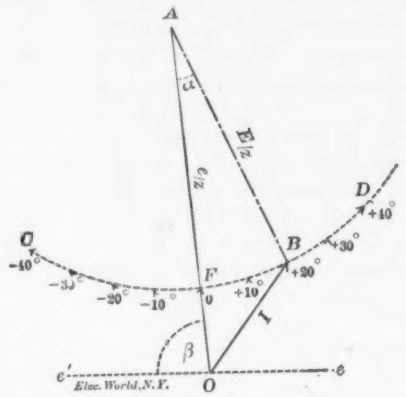

FIG. 167.—ARMATURE CURRENT $\alpha = 20°$ AND $k = 0.75$.

citations and load ratios is shown in Fig. 168, for a single-phase machine operating as a motor, with an armature impedance factor of 10. The lowest curve of $b = o$, or frictionless no load, is a pair of nearly straight lines, each inclined at 45° to the base. Assuming the bus-bar pressure to be 1000 volts, the current commences at half the maximum $\frac{e}{z}$, at 500 volts generated e. m. f., and diminishes terminals is $p_e = eI \cos(eOB)$, and the power in the armature to zero at 1000 volts, increasing again to about 0.5 at 1500 volts. The second curve represents the corresponding condition for $b = -0.1$ or a motor load of one-tenth the maximum possible power $\frac{E^2}{z}$. It will be observed that as the load increases the generated e. m. f. for minimum current diminishes from $k = 1$ to $k = 0.9$.

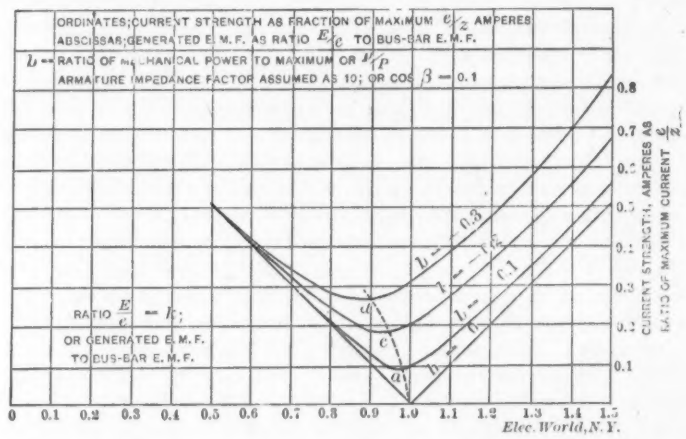
ORDINATES; CURRENT STRENGTH AS FRACTION OF MAXIMUM e/z AMPERES
ABSCISSAS; GENERATED E. M. F. AS RATIO E/e TO BUS-BAR E. M. F.
b = RATIO OF MECHANICAL POWER TO MAXIMUM OR p/P
ARMATURE IMPEDANCE FACTOR ASSUMED AS 10; OR COS β = 0.1
RATIO E/e = k;
OR GENERATED E. M. F. TO BUS-BAR E. M. F.
b = -0.3
b = -0.2
b = -0.1
b = 0
b = +0.1
CURRENT STRENGTH, AMPERES AS RATIO OF MAXIMUM CURRENT e/z
0.8
0.7
0.1
0
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5
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FIG. 168.—CURVES INDICATING THE CURRENT STRENGTH IN A SYNCHRONOUS MOTOR FOR VARIOUS LOADS AND VARIOUS FIELD EXCITATIONS.

Talk of Telephone Consolidation.

Financial papers have recorded rumors of consolidation with the American Telephone & Telegraph Company of the various other American Bell interests, among them the American Bell Company itself. Statements have also been made to the effect that an offer of

225 has been made the Western Union Telegraph Company for the 37,000 odd shares which it owns of the stock of the New York Telephone Company, beside an offer for the Western Union holdings of the stock of the Southern Telephone & Telegraph Company.

Centralized Sources of Energy in Telephone Exchanges—III.

BY KEMPSTER B. MILLER.

(*Concluded from Jan. 14, page 52.*)

Early in 1892 Mr. Hammond V. Hayes, of the American Bell Telephone Company, in Boston, devised a method of supplying current to transmitters which has come into very wide use among the Bell companies, and is, I believe, being installed in most of their modern exchanges. The principles of his method are shown in Fig. 17, where *A* and *B* represent respectively the stations of two subscribers connected by the metallic circuit lines *l* and *l'*, with the central office *C*. The apparatus at the subscriber's station is arranged in two branches, brought alternately into circuit with the line by the hook switch. The circuit which is normally closed during the period of disuse contains a condenser *c* and a polarized bell *b*. The circuit which is normally open, but closed during the period of use of the instrument, contains a transmitter *t* and a receiver *r* in series. At the central office *R* is a repeating coil, having one end of each winding connected at the point *a*, and the opposite ends connected respectively to the terminals *l* and *l'* of the line wires leading to the subscribers' stations. The opposite sides of the two metallic circuits are connected at the point *d*, and between the points *a* and *d* is connected the common battery *B*, preferably composed of several storage cells. By this arrangement the battery is included in a bridge conductor between the sides of the circuit formed by the two connected lines, and one limb of each line includes one of the windings of the induction coil. The current from the battery *B* will, when the subscribers' receivers are removed from their hooks, divide at the point *a* and pass in multiple through the two windings of the repeating coil; thence the two portions of the current will pass through the transmitter and receiver of the two subscribers' stations, respectively, and back to the point *d*, where they unite and pass to the negative pole of the battery.

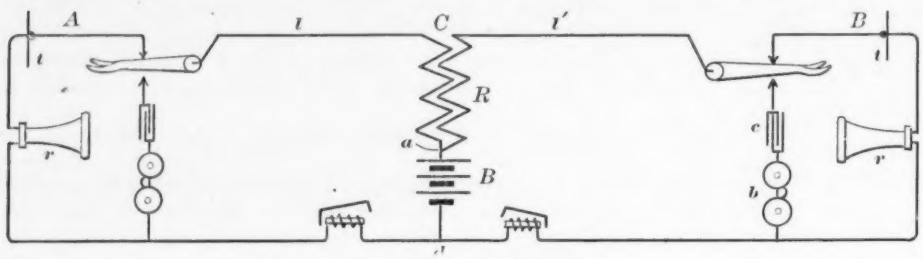


Fig. 17.—Hayes System.

Any changes in the current in either circuit produced by the operation of one of the transmitters will act inductively through the repeating coil upon the other circuit, causing corresponding fluctuations in current to flow through that circuit and actuate its receiver. The transmitter at any station is compelled to vary the resistance of its own line circuit only, and in this way some of the advantages of a local circuit are gained. The two helices of the repeating coil are, under ordinary circumstances, of the same resistance and number of turns and wound side by side on the same core, the resistance of each helix being rather low, usually less than ten ohms. When the subscribers' receivers are upon their hooks no current flows from the battery *B*, because of the condenser *c* at each station, which maintains an open circuit to the steady battery current. Currents from an alternating-current generator at the central station, however, act inductively through the condensers, and ring the polarized bells as if the condensers were not present. The removal of the receiver from the hook at any station lowers the resistance of the line circuit of that station from a practically infinite value to a rather low value, the latter being that of the talking apparatus together with the line wires. This change in resistance is utilized in signaling, an annunciator or corresponding device being placed in each line circuit, and adapted for operating when traversed by the current which the closure of the low resistance path allows to flow through the circuit. This principle is made use of in nearly all of the modern Bell exchanges.

A condenser of about 0.75 microfarad capacity is ordinarily used at the subscriber's station. A condenser of this size serves to transmit alternating or pulsatory ringing currents with great ease. In some cases the condenser *c* is omitted and the magnet of the polarized bell wound to a very high resistance, such as 5000 ohms. In this case there would be a slight leakage from the battery through the signal bell branch at each substation, which in an exchange having a large number of subcribers would mean a rather heavy drain upon the battery.

In practical work a repeating coil, similar to that shown in Fig. 17, is placed on each side of the battery *B*, but the four helices of the two coils are placed upon a single core. The coils with battery between them are bridged across the tip and sleeve strands of the cord circuit instead of across the line wires, as is shown in Fig. 17. A cord circuit thus arranged is shown in Fig. 18, in which *P* and *P'* represent a pair of plugs connected by the strands 3 and 4 of the flexible cords. The two terminals of the tip conductor 3 are connected to the two terminals of the helices h^1 and h^2 of the repeating coil *H*, the other ends of these helices being connected to the negative pole of the battery *B*. In a similar manner the terminals of the sleeve conductor are connected to the terminals of the helices h^3 and h^4, the other terminals of which are connected together and to the positive pole of the battery. If the two plugs are inserted into the jacks of two subscribers' lines it is evident that current from the battery will flow through the winding h^1 and h^3 to the station with which plug *P* is connected, and through the winding h^2 and h^4 to the other station. If the transmitter at the station with which plug *P* is connected varies its resistance, the windings h^1 and h^2 will become a primary coil and act inductively on the windings h^3 and h^4, which thus form together a secondary coil. If the transmitter at the station with which plug *P'* is connected varies its resistance then h^2 and h^4 act as a primary coil, and h^1 and h^3 as a secondary.

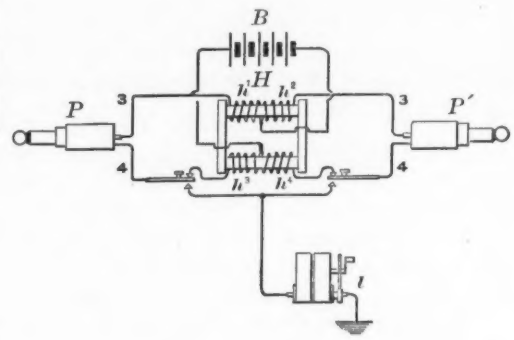


Fig. 18.—Cord Circuit.

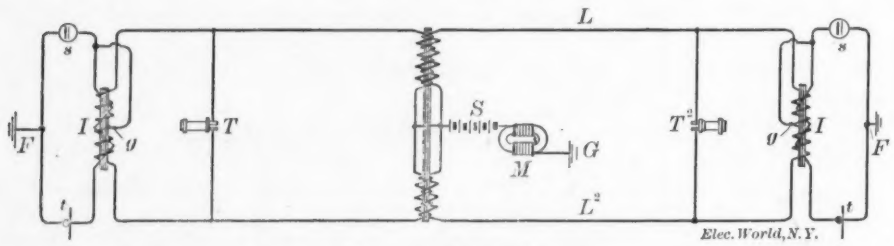


Fig. 19.—Stone System.

The use of secondary batteries at the subcribers' stations supplied by some source of current, either at the central office or elsewhere, has already been referred to. Charles E. Buell, in 1881, was the pioneer in this line. He was followed by Stearns, in 1883, Dyer, in 1888, and Dean, Stone, Scribner and McBerty and others, who have accomplished much in this line of work since 1894. The idea of Dyer, in 1883, was to charge the storage battery from the ordinary lighting mains of a city, the battery then acting in a local circuit containing a transmitter and the primary of an induction coil in the same manner as when a primary battery is used.

In Fig. 19 is shown one of Stone's methods which involves the use of an electrolytic or secondary cell at each subscriber's station. The battery *S* at central is grounded through an impedance coil *M*, its other terminal being connected to the centre point of a divided repeating coil bridged across the two line wires. Across the

terminals of the line wires at each subscriber's station is connected the secondary of an induction coil *I*, the centre point *g* of which is grounded at *F*, through a secondary cell *s*. In circuit with this cell is the primary of the same coil, together with a transmitter *t*.

The operation of this system is easily understood, the current from the battery *S* passing in multiple over the two line wires, through the transmitter and the secondary cell in multiple and returning by ground. When the transmitter is operated variations in the currrent in the local circuit in the substation are produced and act inductively on the line circuit by means of the induction coil. If the cell *s* is discharged, the transmitter may be considered as acting solely by means of the circuit from the battery *S*, the counter e. m. f. of the electrolytic cell serving to divert a considerable portion of this current through the transmitter. If, however, the cell *s* is charged, then the transmitter may be considered as working from the current generated by it and would so work, whether or not the battery *S* were in circuit.

The use of storage batteries or electrolytic cells at subscribers' stations makes possible a full realization of the advantages of the induction coil, but, of course, introduces the disadvantages of having fluid cells at points remote from the central office. They have been used in some cases with apparent success, but their use has by no means become general.

Before concluding, it will perhaps be of interest to describe a complete system somewhat in detail, in order to give the reader a clearer idea of the manner in which some of the methods already pointed out are utilized in practice.

In Fig. 20 is shown a common battery system, as applied to a multiple switchboard, embodying most of the latest ideas in telephone exchange work. Two subscribers' lines *L* and *L*¹ are shown

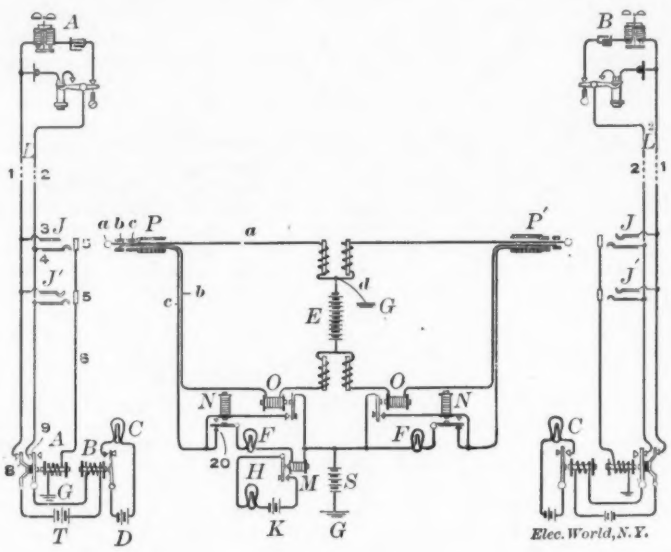


FIG. 20.—MULTIPLE BOARD WITH CENTRALIZED BATTERY.

extending from the subscribers' stations *A* and *B*, through the spring jacks *J* and *J′*, etc., on the various sections of the switchboard. For clearness the two jacks *J* are shown in separate portions of the diagram, as are also shown the two jacks *J′*; but it must be remembered that the jacks *J* are upon the same section of the switchboard, and the jacks *J′* upon another section. Of course, in a large exchange a far greater number of jacks than two would be connected with each subscriber's line, there being in fact one jack for each line upon each section. The line wires of each metallic circuit, after passing through the jacks, pass through the contacts 8 and 9 of a line cut-off relay, the circuit between them being completed through a battery *T* and a lamp signal relay *B*. *P* and *P′* represent a pair of plugs located at one section of the board, it being understood that this pair and the apparatus shown associated with it would be duplicated many times at each section. Across the tip and sleeve conductors *a* and *b* of the cord circuit is bridged a divided repeating coil and a supply battery *E*, this arrangement being readily recognized as that of the Hayes system. The other apparatus in connection with the cord circuit will be readily understood when its operation is described, it being only necessary to state that the relays *O* are contained in the sleeve strand of the cord circuit and serve to control the circuits of the relays *N*, which in turn serve to control the circuits through the supervisory lamp signals *F*.

When subscriber *A* removes his receiver from its hook, a current from the battery *T* flows through the line, actuates the line signal relay *B* and causes the illumination of the lamp *C*. The operator at that station seeing the signal inserts the plug *P* into the jack *J*, thus connecting the two sides of the line with the two sides of the cord circuit. This allows current from the battery *E* to flow through the circuit of the subscriber's line and this current causes the left hand relay *O* to attract its armature and thus complete the circuit through the relay magnet *N*. The insertion of the plug also completes the circuit from the battery *S* to the conductor *c* and contact *c* on the plug, thence to test thimble 5 of the jack and by wire 6 through the magnet of the line cut-off relay *A* to ground. The current flowing through this circuit accomplishes three purposes: First, the attraction of the armature of the relay *N*, thus breaking the circuit through the lamp signal *F;* second, the attraction of the double armature of the relay *A*, thus cutting off both branches of the line circuit beyond the jacks and extinguishing the line signal *C;* and, third, the raising of the potential of all of the test thimbles 5 connected with that line by an amount equal to the drop in potential through the relay magnet *A;* so that any operator at another board attempting to make a connection with this line would be warned upon touching the tip of her plug to the test thimble that the line was busy by a click in her head receiver. Upon learning the connection desired the operator applies the tip of the plug *P′* to the jack of the called subscriber, and if his line is free she will hear no click, because the test thimble 5 will not have been raised to a higher potenital than that of the ground, and therefore no current will flow from the tip of the plug through the right hand upper winding of the repeating coil and to ground by wire *d*. Upon the insertion of the plug *P′* into the jack of the called subscriber the current from the battery S will pass through the right hand cord lamp *F*, through the rearward sleeve of the plug, and by test thimble to the line cut-off relay of the called subscriber's line to ground. This illuminates the lamp *F* aud operates the cut-off relay, as before. The lamp remains lighted until the subscriber *B* responds to the call, when, upon the removal of his receiver from its hook, the current from the battery *E* is allowed to flow through his line. This operates the right hand relay *O*, energizes relay *N*, and thus extinguishes the lamp *F*, at the same time allowing enough current to flow through the magnet *N* to serve for testing purposes and to hold the relay *A* closed.

The subscribers now converse by the methods already discussed, and when either of them hangs up his receiver the circuit through that line is broken at the condenser and the corresponding relay *O* releases its armature. This de-energizes the relay *N* and causes the lamp signal *F* to become lighted as a sign for disconnection. Upon removing the plugs from the jacks all apparatus is automatically restored to its normal position.

In circuit with the lamp *F* of the answering cord is a relay magnet *M*, controling the current of a pilot lamp *H* common to the group of plugs under any one operator. This lamp is placed either on a conspicuous portion of that switchboard or else upon a chief operator's switchboard, and serves at all times to indicate to the chief whether or not that particular operator is properly attending to her clearing out signals.

This particular arrangement of cord circuit relays was devised by Mr. H. M. Crane, of Boston; but the credit for the system as a whole must be shared by several of the engineers of the Bell and of the Western Electric Company.

The Equivalent of a Watt Hour in Mechanical Units.

One way of defining a watt hour is to say that the energy represented by it is equal to that expended in raising a pound to a height of 2654 feet, or two watt hours correspond almost exactly to raising a pound to a height of one mile. Applying this to primary batteries gives results which at first sight are rather surprising, as they show how much energy is stored in them. A certain dry battery, for instance, weighing 6.38 pounds, yielded 130 watt hours, which, if applied to raising the battery itself, would lift it to a height of over 10 miles. In one hour the energy translated in an ordinary 16-cp lamp weighing about an ounce would raise that lamp to a height of 400 miles at a velocity of nearly 7 miles per minute.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE
AMERICAN AND FOREIGN
By Carl Hering.

Dynamos, Motors and Transformers.

SPARKING AT COMMUTATORS.

A simple method of finding which one of the segments of a commutator is causing the sparking is briefly described in the note by Mr. Lovell in the Lond. "Elec. Rev.," Jan. 20. A few of the bad-looking segments should be marked with numbers, and when the dynamo is running it will then appear that the numbers near the sparking segments will appear to stand still, as they are instantaneously lit up by the spark as these segments pass under the brush. The marks should be placed so that they will not be seen over each other. The commutator should be shielded so that it is illuminated only by the sparks.—Lovell. Lond. "Elec. Rev.," Jan. 20.

REFERENCES.

Rotary Converters.—The conclusion of the article noticed in the "Digest" Jan. 28. Various installations are briefly described, in which rotary converters are used, and some illustrations are given. The descriptions seem to be limited to the Alioth converters.—Ritter. "L'Eclairage Elec.," Jan. 14.

Lights and Lighting.

TWO VS. THREE LAMPS IN SERIES.

In Germany an arc lamp is in use which is so constructed that three of them may be put in series on the usual 110-volt circuit, while formerly only two lamps were connected in series on such circuits. In order to compare the illuminations produced and the relative costs, Dr. Wedding made some tests, which are described in a recent paper reprinted in the "Elek. Zeit.," Jan. 19. The new lamps are called the Volta lamps; they require 35 volts each, thus leaving only 5 volts to be absorbed by the dead resistance in series with three of the lamps. He determined the curve of candle power and measured the hemispherical candle power for both the new and the old lamps, the current being 9 amperes for both, and the voltage of the old lamps being 40. The results are given in curves and tables, from which the mean spherical intensity (presumably meaning hemispherical) for the new lamps is 626 candle power and the specific consumption being 0.514 watts per mean candle power. Similar measurements with the old lamps gave 647 and 0.554, showing that both lamps had about the same candle power and efficiency. In practice, however, it is the illumination produced on a horizontal surface that is important, and he therefore made measurements of this illumination at various angles, the results being given in curves and tables. These he then applies to the four cases in which a given hall is illuminated either by two, four or six of the old or by three or six of the new lamps, giving the curves of illumination in each case. As far as illumination is concerned it is sometimes more favorable to the one system and sometimes to the other. The costs in each case are calculated and the results are as follows: By replacing two lamps of the old system by three of the new the annual cost is increased 12 per cent., but there is a gain of 80 per cent. in the illumination; by replacing four lamps of the old system by three of the new the cost is reduced about 40 per cent., and there is a loss of about 30 per cent. in the illumination; by replacing four of the old lamps with six or the new the cost is increased about 15 per cent., and there is a gain of 60 per cent. in the illumination; finally, by replacing six of the old lamps by six of the new the cost is reduced about 23 per cent., and there is a gain of about 10 per cent. in the illumination.—Wedding. "Elek. Zeit.," Jan. 19.

In the discussion Goerges claimed that as the results depended on the carbons used, the figures given are only approximations. An alternating-current lamp can be made much more effective with reflectors, whereby the life of the carbons is also increased; the economy may also be increased somewhat by using slightly smaller carbons; his company (the Siemens & Halske) found that with the same carbons and the use of reflectors the time of burning is increased by 10 per cent., and with continuous-current, 50 per cent.; the particular shape of the reflector is of great importance, conical reflectors being apparently preferred. According to their experience the differential lamp gives the finest regulation. They found that shunt lamps require a loss of about 30 per cent. of the voltage in the dead resistance, while differential lamps required only 15 per cent.; this depends also on the number of lamps in series; in general it may be said that with a loss of 15 per cent. in the volts the current variations will be from 8 to 10 per cent. With alternating currents the dead resistance may be smaller than with continuous, as the regulating mechanism is more sensitive, due to the vibrations. They have found that for continuous current the lower limit is 10 per cent., and for the alternating current 5 per cent. Luxemberg thought the results obtained by Wedding were those which might have been expected. In a previous publication he showed that a shunt lamp will operate best—that is, there will be a minimum of variations in the light—when the dead resistance is so great that the loss of voltage is equal to that in the arc—that is, for two lamps in series it consumes one-third of the whole energy; the variations will then be equal to those in a differential lamp; with the latter the case is different, as the variations are constant whatever value the resistance has; it is therefore possible by the use of differential lamps to obtain a greater output of light, even when there are only two lamps in series. In making comparisons between two and three lamps the former should be run at 45 or more volts, and the results might therefore be more favorable for two lamps than for three. Another reason why two lamps should be preferred is that the number in series ought to be reduced to the least possible, so as to make the lamps more independent of each other. The Volta lamp referred to by Wedding is in principle merely the old differential lamp, in which there is a constant relation between the voltage and the current strength, and therefore a constant resistance of the arc. To use three lamps involves a much larger current rush when the lamps are started; it will be about 22 times the normal current, and it is therefore advisable to use a starting resistance, which is gradually cut out, as with motors. Goerges stated that Siemens & Halske have adopted about 40 volts for 9 and 10 ampere lamps, and 45 for 20 ampere lamps. Starting resistances such as those just referred to he states have been, and are, in use. Wedding, in his reply, gave some further details of the tests in order to show that the results should not be termed mere approximations.—"Elek. Zeit.," Jan. 19.

TESTS WITH A HEADLIGHT LAMP.

Results of some tests of the Wagenhals lamp for locomotives and electric cars, constructed by the Dayton Company, of Ohio, are described by Mr. Schiemann in the "Elek. Zeit.," Jan. 19. As will be remembered from previous descriptions of this lamp, it is characterized by the fact that it contains no automatic regulating apparatus, and that the arc is produced in an enclosed globe, so placed that the arc is in the focus of a parabolic reflector. The lamp is intended to be run from 500-volt circuits, and therefore has considerable resistance in series with it. He made tests first with 80 volts and then with 500, measuring the length of arc, the voltage at the carbons, the current and the required external resistance. A prolonged test gave the somewhat unexpected result that the lamp will burn for 19.5 hours without any adjustment, during which time the arc increased from 3 mm to 45 mm, which corresponds to a consumption of carbons of 2.15 mm in one hour; in spite of the hour length of the arc at the conclusion of this test the lamp burned quietly and was not extinguished by shocks or vibrations. The dead resistance in circuit with it was 86 ohms, while hot, and the current was from 3.8 to 5.4 amperes. The results with 500 volts were much better than those with 80 volts, and the lamp burned more quietly and brightly; 110 volts, however, would be sufficient to run the lamp quietly, although the length of arc obtained without regulation would not be so great, thus requiring more frequent hand regulation. This regulation consists simply in pressing a knob which allows the upper carbon to fall until it touches the lower; releasing the knob then raises it again for a short distance, thus establishing the arc. The consumption of energy for a current of 5 amperes, including that in the resistance, was 2500 watts. When applied to a car it was found to illuminate the street quite well to a great distance, but no photometric measurements seem to have been made. The large amount of energy lost in the resistance can be used in winter to heat the car. Calculations are made on the basis that the lamp is used for 1900 hours per year, and that the cost of the energy is 2.5 cents per kw hour, and it shows that the total cost, including carbons, is $120 per year, of which $15.5 is chargeable to the light and $104.5 is chargeable to the heating.—Schiemann. "Elek. Zeit.," Jan. 19.

Power.

APPLICATION OF THE ELECTRIC MOTOR TO PRINTING PRESSES.

The printing office of the United States Government, in Washington, is equipped with electric motors, and is probably one of the best illustrations of this application of motors. It is in charge of Mr. Tapley, who recently read a paper before the Franklin Institute on this subject, in which he gave the result of his experience, which cannot fail to be of interest to those concerned with this application of electric motors. A brief abstract is given in the N. Y. "Elec. Rev.," Feb. 1. After calling attention to the importance of first becoming familiar with printing-press work, he gives a number of the conclusions arrived at from his experience. Of series, shunt and compound motors, the latter are the most satisfactory. Only geared and direct-connected motors are distinctly advantageous over belting from a main line of shafting, and the selection between these must be decided in each individual case. The control of the press must be positive and there must be provision for a suitable range of speed; but arrangements should be made if possible to operate at a uniform speed, thus doing away with the demand for wide extremes, which are rarely used. Of the various methods of control, the combination of the armature

and the field control is best. Armature control, with carefully proportioned gearing in sizes up to 5 horse-power, is a dangerous rival of the direct-driving motors. All individual motors should be attached to the frame of the press, so as to be part of it, and not on a separate foundation. Geared motors should have a rawhide pinion with a brass sleeve and sides, and only a single reduction should be used, ratios of 10 to 1 being permissible when the speed is not over 120 revolutions per minute, while 5 and 3 to 1 should be used for 175 revolutions and upwards. Direct-connected motors should be used when noise is an objection, as well as on all large presses, especially for newspaper work. Each equipment should have an automatic circuit breaker, which will not only protect the motor, but also the more expensive press; he considers this an absolute necessity. The cost of direct as compared with geared equipments for new presses is 25 to 33.3 per cent. more for the former; but where old presses are to be changed the cost is about the same, as the gearing and fixtures amount to the difference in cost between the motors. This applies to 5-hp motors and larger, as smaller sizes may cost very much more, sometimes double. The chief advantages of substituting individual motors for belting are economy of power, positive speed, ability to locate a faulty press, freedom from dust and dirt, higher grade work and increased output, which should amount to 15 per cent. without extra wear on the machinery, and this, he claims, will easily pay for the electrical equipment within three to five years. When properly installed the repairs amount to practically nothing. With flat-bed presses printing 32 pages 16mo per impression, 21,000 kw hours can be secured, including "making ready"; at 5 cents per kw hour 4200 pages can be printed for 1 cent. Web presses, doing the same class, size and grade of book work, will print, cut and fold 91,000 pages per kw hour, or at the rate of 18,000 for 1 cent, which is a balance of 4.5 times in favor of the web presses. When a large number of presses are used a safe ratio of 5.5 to 1 can be taken as the horse-power in motors to the horse-power in generators.—Tapley. N. Y. "Elec. Rev.," Feb. 1.

REFERENCES.

Power Plant.—An illustrated description of the power plant of the American Soda Fountain Company at Boston.—Weller. N. Y. "Elec. Eng.," Jan. 26.

Shoreditch Dust Protector.—A discussion of some of the data.—Raworth. Lond. "Elec. Rev.," Jan. 20.

Traction.

UNDERGROUND RAILWAY IN PARIS.

A brief, illustrated description of the system of underground electric railways which is to be constructed in Paris, and is to be equipped by the Westinghouse Company. It forms a circuit with a number of irregular diameters, passing into and through the central portions of the city. The total length of lines to be constructed is about 65 kilometres, 70 per cent. of which is underground, 14 per cent. in open cut, and 16 per cent. over viaducts. The whole system is to have a double track. The estimated cost is about $875,000 per mile; the city will construct all the underground work, viaducts, etc. Work on the construction of this road has begun.—N. Y. "Elec. Eng.," Jan. 26.

REFERENCES.

Electric Railways in Porto Rico.—A short, illustrated article on the exploitation of electric railways in Porto Rico, in which the author shows that the establishment of such railways would be desirable, easy and relatively inexpensive, as there exists throughout the mountain range natural water powers, which are numerous and powerful.—Lluveras. "Eng. Mag.," Feb.

Cost of Energy for Traction.—A reprint of a table prepared by the engineers of the Orleans Railway, who made a tour through America to study traction installations. A table gives the cost of the station and its operation for the Baltimore & Ohio Railroad plant, in Baltimore; for four roads in Chicago and three in Brooklyn.—"L'Eclairage Elec.," Jan. 14.

Canal Traction.—A note stating that a large company has been formed in Belgium for the introduction of mechanical traction in canals in all countries by the different electrical systems.—"L'Elec.," Jan. 14.

Installations, Systems and Appliances.

CENTRAL STATION AT GIBRALTAR.

A brief description, accompanied by a large number of illustrations, of the new plant in the English possession at Gibraltar is published in the Lond. "Elec.," Jan. 20. The plant is chiefly for lighting, both public and private; steam alternators are used, the voltage on the feeders being 2000, with a frequency of 73. There are five substations, feeding a two-wire network at 110 volts, and a three-wire network at 220 volts for street lighting. The capacity of the complete station is 10,000 lamps of 16 candle power, and at present about 500 lamps are in use for street lighting. The arrangement for feed-water supply and for condensing are said to be the most perfect of their kind in spite of the difficulties in arranging for a supply of feed and circulating water. All the mains consist of concentric cables, both conductors being insulated and the cable being lead-sheathed, armored and finally yarned; the cables are laid directly in the ground, chiefly under the foot-paths.—Lond. "Elec.," Jan. 20.

REFERENCES.

System of Meter Rates.—A reprint of a paper read before the Northwestern Electrical Association. The author believes that due consideration has not been given to the cause of one of the defects of central stations, which are all operated at a poorer rate of economy than any other class of power plants, as they are in operation only a few hours a day; nor of the means to remedy this defect, which, it is claimed, would result in a surprising amount of benefit. The object of his paper is to attempt to show how these conditions are affected by the system of rates employed. The methods which he suggests involve differential rates.—Debell. N. Y. "Elec Eng.," Jan. 26.

Central Stations in the United Kingdom.—A very large table published as a supplement, giving numerous well-filled columns of statistics for the various stations in London and the provinces, divided into alternating-current, low-pressure continuous-current and high-pressure continuous-current systems. No general summary is given.—Lond. "Elec. Rev.," Jan. 20.

Central Stations in the United Kingdom.—A supplement in the form of a map showing, in different colors and signs, the central stations in the United Kingdom; the map shows whether they use the continuous or the alternating current, and whether they are operated by a municipality or are in progress of construction.—Lond. "Elec.," Jan. 20.

Switches and Interrupters.—A brief account of a recent discussion and exhibit at the International Society; no illustrations are given, and the brief report appears to contain nothing of importance.—"L'Ind. Elec.," Jan. 10, and "L'Eclairage Elec.," Jan. 14.

New Accumulator Switch.—An illustration of the other form of switch which was mentioned but not reproduced in the abstract given in the "Digest," Jan. 28.—Erlacher and Besso. Lond. "Elec.," Jan. 20.

Three-Phase Plant.—A note describing what he considers a curious effect, which he cannot explain, when an additional generator was attached to a primary circuit.—Gibson. Lond. "Elec. Rev.," Jan. 20.

Selection of Meters.—Some of the chief points to be taken into consideration for the selection of meters for a station.—Lond. "Elec. Eng.," Jan. 20.

English Lighting Statistics.—A reprint of some of the statistical diagrams referred to in the "Digest" Jan. 28.—N. Y. "Elec. Eng.," Jan. 26.

Wires, Wiring and Conduits.

REFERENCES.

Aluminum as an Economic Factor.—A short article, mainly on the copper trust, showing that the high artificial price of copper is making aluminum a competitor.—Wentworth. "West. Elec.," Jan. 28.

Electro-Physics and Magnetism.

EFFECT OF PRESSURE ON THE INITIAL CAPACITY OF POLARIZATION.

Researches were recently made by Mr. Chassy, and described in a French Academy paper, reprinted in "L'Ind. Elec.," Jan. 10, in which he endeavored to determine whether the initial capacity of polarization is subjected to the same influence as was found to be the case with accumulator plates of platinum sponge, whose capacity increased enormously with pressure; he endeavored to find whether the charge produced by a very small e. m. f. would also be increased with the pressure. He operated with pressures up to 2000 atmospheres, and used acidulated water. In all cases he found that the initial capacity of polarization was nearly independent of the pressure. He concludes that the phenomena of initial polarization does not correspond to an electrolytic decomposition of the gaseous elements. He suggests defining the e. m. f. of decomposition of water as that which produces a charge varying with the pressure.—Chassy. "L'Ind. Elec.," Jan. 10.

GOLD AND PLATINUM COHERERS.

It is often thought that gold and platinum are unsuitable metals for making coherers, but Mr. Branly, in a recent French Academy paper, published in "Comptes Rendus," Dec. 26; "L'Ind. Elec.," Jan. 10; "L'Elec.," Jan. 21, and noticed briefly in the Lond. "Elec.," Jan. 20, shows that on the contrary they are highly sensitive, and are capable of giving very constant results, but require some care. Several metals will give different results in the hands of different observers. To obtain similar results only sifted filings should be used, and the diameter of the grains and their mass should bear some relation to the voltage of the cell which is in series with the coherer circuit. The results are in accordance with Lodge's theory, if it is supposed that even the nobler metals are not in contact under ordinary circumstances.—Branly. "Comptes Rendus," Dec. 26; "L'Ind. Elec.," Jan. 10; "L'Elec.," Jan. 21; noticed briefly in Lond. "Elec.," Jan. 20.

REFERENCES.

X-Rays.—A long article by Sagnac on the transformation of X-rays by materials; a long abstract of a French Physical Society paper by him on the same subject and long, illustrated abstracts of two articles from the Italian on the diffusion of X-rays, by Malagoli and Bronacini.—"L'Eclairage Elec.," Jan. 14.

Experiments with the Brush Discharge.—A reprint in full of his long. Brit. Assn. paper.—Cook. "Phil. Mag.," Jan.

Electro-Chemistry and Batteries.

ELECTROCHEMICAL AND METALLURGICAL INDUSTRIES IN 1898.

In the conclusion of Mr. Kershaw's article (see "Digest" last week), published in the Lond. "Elec. Rev.," Jan. 20, he refers briefly to the remaining industries. The copper-refining industry is briefly discussed; he believes that there are at present thirty-one electrolytic refineries, of which nine are in America, seven in Germany, six in France, five in England, three in Russia and one in Japan, besides five copper depositing works using the Elmore and the Dumoulin processes. In 1899 there will probably be thirty-nine works in Europe and America. Concerning the chlorates of potassium and sodium he states that their electrolytic manufacture has not yet been introduced into England, although the electrolytic alkali factories in the United Kingdom are larger than those found in any other country. The number of chlorate works is now seven, located at Michel, Chedde, Vallorbes, Bitterfeldt, Leopoldschall, Mansboe and Niagara. The aggregate power available is about 30,000, and the present output of these works he estimates to be about 6500 tons; the progress is therefore striking, considering that eight years ago this was in its infancy. The manufacture of the hypochlorites of sodium or magnesium for bleaching purposes is slowly extending, and a fairly large number of paper pulp mills and textile-bleaching works in France and Germany now have their own electrolytic plant. In cellulose factories the Kellner apparatus and process, and for bleaching textile goods, the Vogelsang form of apparatus, are generally used. He knows of no place in England that has adopted these new methods of bleaching. There are no further developments in connection with the Hermite sewage disinfection process; the unfavorable results of experimental trials seems to have checked further work. There is little progress of importance to report concerning ozone. Experimental work is being carried out in many places, but he knows of no case in which ozone is applied commercially except in the case of the Otto method of manufacturing vanillin. The chief event in the last year concerning the electrolytic zinc industry is the definite abandonment of the Ashcroft process, the failure of which is attributed to the diminished metal value of the ore, the difficulties due to the accumulation of manganese, and the lack of the necessary financial support. Four wet extraction processes are still in operation, although only two are working on a commercial basis. The Hoepfner process is operated at Winnington, and at Fuerfurth, in Germany. In 1897 1200 tons of zinc were produced by this process at these works. The Dieffenbach process is worked at Duisberg, Germany, and is said to be producing 90 tons monthly. In both of these zinc chloride is used, and it is questionable whether they would prove profitable if it were not for the chlorine liberated at the anode. The Cowper-Coles process is in experimental operation in Cornwall. He believes, with others, that the problem of the zinc extraction from refractory and sulphide ores will be solved by the dry or fusion process, and for this reason the Swinburne sulphide ore process is of interest. A non-electrical fusion process has emerged from the experimental stage and may cause a serious fall in the price of zinc. There is not much to report concerning the electro-galvanizing industry; the Cowper-Coles process is used by several firms in that country, as is also the Greenwood process, while abroad the Alexander and the Richter processes are used. In conclusion he adds that in nearly every case in which electricity has been applied to the remaining smaller manufactures and industries it has proved successful, and the new methods have displaced, or are gradually displacing, those previously used.—Kershaw. Lond. "Elec. Rev.," Jan. 20.

ENCLOSED ELECTRIC FURNACE.

A brief description, with some illustrations, of a calcium carbide furnace which was recently tested at the Armour Institute at Chicago is given in the "West. Elec.," Jan. 28. The upper electrode is hollow, and the material is to be fed through it. The lower one has an area of about 1 square foot. The results of the test seem to be that it is unsatisfactory to feed the material in cartridges or as a powder; the experiments are to be continued with the material fed in compressed form.—"West. Elec.," Jan. 28.

REFERENCES.

Electricity Direct from Coal.—A reprint of a short paper read before the Northwestern Electrical Association, in which the author gives a brief review of a number of the principal articles on this subject, all of which have been noticed in the "Digest" and Elec. World. In closing he states that "we are chasing no 'will-o'-the-wisp' in working upon this interesting and far-reaching problem. What is necessary is to discover the right conditions."—Rogers. N. Y. "Elec. Rev.," Jan. 25, and N. Y. "El'ty," Feb. 1.

Accumulator Construction.—In this continuation of his long serial he discusses the charging and discharging difference of potential, defines the various meanings of the term efficiency, and describes the condenser method of measuring internal resistance of batteries.—FitzGerald. Lond. "Elec. Eng.," Jan. 20.

Sugar Refining.—A short note on some recent tests made in Prussia to determine the utility of the Say-Gramme process.—"Zeit. fuer Elek.," Jan. 15.

Units, Measurements and Instruments.

INTENSITIES OF SEARCHLIGHTS.

Some time ago Professor Blondel stated that the luminous intensity at any point of a surface cutting a projector beam at right angles may be represented by the product of the intensity of the source, the coefficient of transmission, and the coefficient of optical effect, the latter depending on the structure of the apparatus. In a recent French Academy paper, published in "Comptes Rendus," Jan. 31, 1893, and noticed briefly in Lond. "Elec.," Jan. 20, Messrs. Blondel and Rey have verified this for a Mangin projector, using a screen in front of the projector pierced with a number of holes of equal sizes, which enable the light from any particular point to be projected on to a photometer screen. By placing these holes at regular intervals across the surface, a very exact estimate is said to be obtained of the candle power of successive zones. It was found that the luminosity was practically constant except in the central portion, where it was zero; it is also diminished slightly toward the outside of the beam. By adding up the illuminations found for the various zones the total effect of the beam may be obtained in the laboratory itself. Measured in this way a Mangin mirror (the size is not given in the abstract) yielded 55,719,000 candle power.—"Comptes Rendus," Jan. 31, 1898; abstracted briefly in Lond. "Elec.," Jan. 20.

IMPROVEMENT IN METERS.

In order to overcome the errors introduced by mechanical friction in meters of the motor type, including not only that at the brushes but also that in the registering gearing, Dr. Hiecke devised an improvement, which he describes with the aid of an illustration, in the "Zeit. fuer Elek.," Jan. 15. It consists simply in driving the commutator and the registering gearing from a separate source, which in this case is a clockwork wound up electrically. This winding mechanism is released by an escapement, which acts when the arrangement needs to be wound up. In this way he has increased the sensitiveness of the Thomson-Houston meter so that it starts with a load of less than 1 per cent. of the full load, while the deviations from the true value at one-tenth, one-half and full load averages less than 1 per cent. Moreover, the brushes may then bear quite heavily on the commutator, and need, therefore, not be made of one of the noble metals. The arrangement also enables the mechanical friction to be compensated without the aid of the usual additional winding, therefore making the meter independent of all variations of the voltage.—Heicke. "Zeit. fuer Elek.," Jan. 15.

MERCURY VOLTAMETER.

An illustrated description of a voltameter in which both electrodes are mercury, and which may be used for large or small currents, is given by Mr. Gurwitsch in the "Zeit. f. Elektrochemie," Jan. 5. The amount of mercury dissolved is measured, not by means of the weight, as usual, but by its volume as indicated in a capillary tube. The mercury for the one electrode is contained in an open vessel, which is inside of the one containing the mercury for the other electrode; thus both electrodes are horizontal and about on the same level. The solution contains 50 gr. of mercury in the form of nitrate, and 100 gr. of potassium nitrate per liter. No trouble arises in keeping the solution from decomposing, if it is kept in the dark and in a nearly air-tight vessel. The results of some comparative tests are given.—Gurwitsch. "Zeit. f. Elektrochemie," Jan. 5.

REFERENCES.

Instrument for Measuring the Torque of Motors.—A description with the theory, of a small, portable instrument, which is applied like a speed counter and measures the torque of motors.—Boucherot. "Bul. Soc. Int. des Elec.," Dec.

Telegraphy, Telephony and Signals.

INDUCTION TELEGRAPHY.

The three papers on induction telegraphy read before the English Institution of Electrical Engineers, by Lodge, Evershed and Preece, were discussed jointly, a long abstract being published in the Lond. "Elec.," Jan. 20. The discussion seems to contain considerable of interest to those working in this field, but only a few of the more important statements can be noticed here. Evershed, as well as several others, admitted that if induction telegraphy ever came into practical use it would not replace or displace telegraphy over wires, but would be used where a wire or cable could not possibly be laid; there seems to be a general consensus of opinion as to this; he claimed that it was therefore merely a matter of cost. The most important part of all is the receiving device and the power it requires to work it, as only a very limited amount of the power is received by the secondary circuit. He agrees with Dr. Lodge that the circuits should be laid in the plane of the earth with their magnetic axes vertical, and he had from the first advocated this arrangement. In some cases the cost is prohibitive unless means are provided for using an immense amount of power; the cost is chiefly a question of the price of the power. For the transmitting devices interrupters should be used, even though they give some trouble from sparking, which could be overcome to some extent by a condenser. The receiver should probably in every case be a vibratory instrument. Concerning the economic current in a telephone, Lord Rayleigh had found that 1.6 milli-ampere turns of the alternating current gave a clearly audible sound, and 0.8 a sound which was just audible; Evershed and others were able to hear with 1.4 millia-ampere turns distinctly enough for signaling, and they could even hear quite distinctly with half of that. He refers briefly to some of his experiments, giving data. Fleming called the two practical methods the closed-circuit and the open-circuit systems. The Preece method elaborated by Lodge virtually consists in a gigantic air-coil transformer, the coils of which might be several miles apart, Lodge taking advantage of the resonance effect to increase the voltage. This is the system which he refers to as the closed-circuit

system, the other being the Marconi. He was led to the conclusion, in studying the Branly detector, that it responded to a certain maximum e. m. f., the metallic filings passing from a condition of nearly perfect non-conductibility to a high degree of conductibility when the mass was submitted to a certain critical or breaking-down e. m. f. In the closed-coil system the secondary coil axis should be placed parallel to the magnetic force at its locality, while in the open-circuit system the secondary or receiving wire should be parallel to the electric force, both of which he illustrated by experiments. He also described experiments made with the absorptive power of water for electro-magnetic disturbances. A copper wire one-eighth of a mile long was laid in a lake, and one end was attached to the spark-ball terminal of an 8-inch induction coil, the other end being attached to one terminal of a coherer. It was found that no electromagnetic impulses could be made to travel along the wire, although when lifted out of the lake on to the dry land the waves traveled along it freely. The experiments showed the impracticability of the suggestion to use the coherer as a relay for submarine telegraphy through bare wires. His opinion is that in none of the practical Hertzian-wave telegraph systems at present carried out is there any true electric resonance effect; before this can be achieved it would be necessary to have a transmitter which would not merely create irregular or intermittent impulses, but would establish continuous and uniform wave disturbances of high amplitude and small wave length. Webber called attention to a remark in Dolbear's paper of 1882, in which he suggested an induction system without wires. Whitehead referred to the question concerning the correctness of Maxwell's equations. Mance suggested that instead of breaking and making vibrations for signals the note of the vibration should be altered, as he thinks greater sensibility may thereby be obtained. Senett referred to experiments in transmitting some vibrations through the water, and was strongly of the opinion that no electric current or influence was necessary; it was surprising how many miles the audible sound from a siren would travel. He recommends tuning the receiving diaphragm to the greatest possible sensibility, and believes that sounds may be transmitted 20 to 30 miles in this way. Ayrton referred to the importance of Whitehead's theoretical investigation, and upheld Maxwell's equations, believing them to be correct. He also referred to the absorption by sea water. Lodge, among other things, said that he found that the energy required to work his magnifying telephone was a millionth of a millionth of a watt for giving an audible signal, the magnifying telephone being about 30 times as sensitive as the ordinary one. Granville discussed the practical side of the question of wireless telegraphy. Brett thought that the wave method had the enormous advantage that experiment was considerably easier. Sinclair called attention to the use of the earth, as it seemed to be taken for granted that it behaved at different places in a constant manner. From very long experience he found that it varied very much; in a sandy soil, at about the level of the sea, it was almost impossible to get anything like a good earth, while with a clay soil it was almost impossible not to get a good earth. It was easy to establish an earth connection between two points 50 to 100 miles apart, but it was an altogether different matter to do so when they are only half a mile apart. Brown said that it had been shown that a low frequency was best for transmitting energy, but a high frequency was better for affecting the most sensitive receivers, and he suggested the practicability of using both the advantages, transmitting the energy at low frequency and having the receiver affected by the frequency best adapted for it. Following this discussion is a brief note by Whitehead referring to Maxwell's equations.—Lond. "Elec.," Jan. 20.

TELEGRAPHIC TRANSMISSION OF DRAWINGS.

The system suggested by Mr. Lowd, in this country, some years ago, is again revived by Dr. Walter, of Geneva, who, in the "Elek. Zeit.," Jan. 19, describes and discusses at some length a modification of this system, with special reference to transmission by means of the Hughes printing telegraph, which is so common in Germany, the various letters being so selected as to be in the most convenient order for the Hughes apparatus. The system consists simply in dividing the drawing into a large number of equal squares, enlarging the drawing first if necessary. All these squares are indicated by letters, and the drawing is then telegraphed by sending the letters corresponding to the squares, which are black—that is, those through which the lines pass. At the receiving end these squares are then blackened on a similarly divided sheet, thus reproducing the drawing. He proposes dividing the original drawing into large squares, each of these into smaller ones, and each of these again into smaller ones, so as three letters would indicate a small square, the first one referring to the large one, the second one to the medium, and the third to the smallest. The points in each medium sized square are all telegraphed before those in the next square are begun. He admits that the system would be somewhat expensive, owing to the large number of letters that would have to be transmitted; a portrait 4 by 6 cm, made of a pen-and-ink drawing, would require about 240,000 squares of 1 mm each, and assuming that about one-fourth contain lines, it would require two hours to transmit the necessary letters; from Berlin to London this would cost $250. The transmission, however, is greatly simplified for a large class of drawings, such as those in patent applications, involving chiefly circles and straight lines, which can be indicated by a greatly abbreviated method, which he describes. Two examples are shown (but not as they are received). No difficulties would be involved in transmitting colored drawings, as the squares for each color can be telegraphed first, then those of the next color, and so on. It is thought that the method would be of great use during war, as the location of troops on maps could readily be indicated.—Walter. "Elek. Zeit.," Jan. 19.

The subject is discussed editorially, and attention is called to the fact that as the words formed by the letters have no meaning, errors would be likely to arise which in telegraphing true words could be avoided; there would be no way of recognizing an error by the context. The system might therefore involve a repetition of the message, which is expensive. But in spite of the expense and the time required, it is thought that there might be a field for this system when applied to great distances over which the mail could not compete. The letters indicating the squares, it is suggested, might be prepared by the sender and translated by the receiver, thus relieving the telegraphers of this part of the work.—"Elek. Zeit.," Jan. 19.

WIRELESS TELEGRAPHY.

Mr. Strecker, who recently experimented in Germany with wireless telegraphy, or spark telegraphy, as he prefers to call it, read a brief paper on some investigations, which is reprinted in the "Elek. Zeit.," Dec. 15, and abstracted briefly in the Lond. "Elec.," Jan. 20. In the Marconi experiments vertical wires were used, and as their length had to be quite great, it involved difficulties. The present experiments were undertaken to find whether horizontal wires would not answer the purpose as well, as it would not involve nearly the difficulties to run horizontal wires to considerable length along the usual telegraph poles; longer waves can thus be used than with vertical wires. In order to determine the conditions under which horizontal wires can be used, experiments were made last summer in the neighborhood of Berlin, and these are described in the present paper, which is contributed from the government telegraph department. The experiments showed that with horizontal wires the transmission was possible for 5.7 kilometres (3.4 miles), which was more than 50 times the length of the end wires, and that for these end wires the method of supporting the ordinary telegraph lines may be used. He tried various types of coherers, some of brass filings and some of nickel, and others of both, but there appeared to be little to choose between them; it was found necessary, however, to oxidize the nickel filings slightly. The electrodes were small, cylindrical pieces of brass or strips of silver placed 2 or 3 mm apart. The wires connected to the transmitting and receiving apparatus were 100 metres long, and were parallel to each other, the distance between them being 5.7 kilometres. There were no obstacles between the wires. Several wires were connected in parallel, but it is not shown whether this was an advantage.—Strecker. "Elek. Zeit.," Dec. 15.

A reprint of the brief discussion of his paper is published in the "Elek. Zeit.," Jan. 12.

WIRELESS TELEGRAPHY INSTALLATION.

A note stating that an installation is now in regular use between the East Goodwin light vessel and the South Foreland lighthouse, a distance of 12 miles, not 3 miles, as was stated before. This installation was started without a hitch on Christmas Eve, and has continued in satisfactory use ever since, notwithstanding the terrific storms which were experienced since then. The company operating the wireless telegraph system (presumably the Marconi) is said to be waiting only for the permission of the French Government to put up a station on the French side of the channel in order to establish communication across the channel from England to France; it is expected that this permission will soon be granted.—Lond. "Elec. Eng.," Jan. 20.

ELECTRIC BELL.

In a new for described and illustrated in the "Elek. Zeit.," Jan. 19, the automatic make and break is made a separate apparatus, not attached to the bell itself, as is usually done. This make and break could then be placed in the main battery circuit, and only one would be required for each battery, no matter how many bells there are. This simplifies the construction of the bells and cheapens them. It is also claimed that a fuller note is then produced by the bells, as the makes and breaks are made less rapid; the bells are not so apt to rattle as they do now.—"Elek. Zeit.," Jan. 19.

REFERENCES.

Multiplex Telegraphy.—An Academy note in which he describes, though not very clearly, a solution of the problem by using electric oscillations. He states the problem as follows: Given a number of stations distributed along a single wire, find an arrangement which enables simultaneous telegraphic and telephonic transmission to take place between any two of these stations. A test made with five tuned resonators is briefly referred to.

Interurban Telegraphy in Italy.—A typographical error occurred in the reference on this subject in the "Digest" Jan. 28, the word "Telegraph" in the title should have been "Telephony."

Telephone Exchange at Syracuse.—A brief, illustrated description of this exchange, which is said to be an excellent example of such an exchange.—Rogers. N. Y. "Elec. Rev.," Feb. 1.

Ultra-Violet Light Telegraphy.—A reprint of the illustrations accompanying the description of Zickler's system, noticed in the "Digest" Aug. 13.—N. Y. "Elec. Eng.," Jan. 26.

Counting Mechanism for Telephone Lines.—A brief, illustrated description of Scribner's system of counting the connections.—N. Y. "Elec. Eng.," Jan. 26.

Recent Progress in Telephony.—A very brief abstract from a new edition of a telephone handbook.—Webb. "West. Elec.," Jan. 28.

Miscellaneous.

PRIZES AWARDED BY THE FRENCH ACADEMY OF SCIENCES.

A list of the prizes which have recently been awarded by the French Academy of Sciences is published in "L'Ind. Elec.," Jan. 10, and "L'Elec.," Jan. 14. They are briefly as follows: Ravier was awarded a prize for his treatise on the deviations of the mariner's compass, in which he treats the subject purely geometrically. The Wilde prize was awarded to Wilde for his magnetarium, an apparatus described in the "Digest" some years ago, which enables one to reproduce on the surface of a sphere with surprising exactness the distribution of the elements of the earth's magnetism and their secular variations. The same prize was also awarded to Schott (of Washington) for his work concerning terrestrial magnetism, shown in the annual reports of the United States Coast and Geodetic Survey. The Gegner prize was awarded to Mme. Curie for her researches on the magnetic qualities of steels, and on the emission of uranium rays. The Houllevigue prize was awarded to Branly for a number of his researches. The Kastner-Boursault prize was given to Blondel and Dubois for their treatise on electric traction, and to Janet for his work in connection with instruction on electricity.—"L'Ind. Elec.," Jan. 10, and "L'Elec.," Jan. 14.

EARTHS.

In a recent discussion in London, Mr. Sinclair remarked that it was not correct to take for granted, as is often done, that the earth behaved in the same way at different places. From very long experience he found that it varied very much. In a sandy soil, for instance, when at about the level of the sea, it was almost impossible to make a good earth connection, while in a clay soil it was almost impossible to make one which was not a good earth.—Lond. "Elec.," Jan. 20.

REFERENCES.

Heating Apparatus.—A brief description of the Alioth apparatus, in which heat is generated by Foucault currents produced by the alternating magnetic field in the metallic parts which are to be heated. It is claimed that the efficiency is high because the heat is produced only where wanted. The wire forming the coil need, therefore, not be insulated so as to withstand the heat, as it is not generated in that wire, thus simplifying the question of its insulation.—Ritter. "L'Elec.," Jan. 21.

New Austrian Patent Law.—A reprint of a paper before the Austrian Electrical Society.—Tischler. "Zeit. fuer Elek.," Jan. 15.

The "Crown" Hand Lathe.

The Seneca Falls Manufacturing Company, 422 Water Street, Seneca Falls, N.Y., calls attention to its new hand lathe which is recommended particularly for turning, boring, drilling, polishing, etc. The head spindle is made from a crucible steel forging and has a 17-32 inch hole through it. The bearings are phosphor-bronze, and are provided with the company's improved end-thrust ball-bearing spindle, which, it is said, reduces the friction 75 per cent. in drilling, etc. The cone pulley has three sections for a 1¼-inch belt.

The tail spindle is of steel, arranged with the company's improved combination lever and screw motion, and is provided with self-discharging centre and improved spindle locking device. The tail stock has a bearing of six inches on the bed and is rigidly held in position by a cam-locking arrangement. The foot power consists of double treadles with a walking motion, and the lathe can be started and stopped instantly. This lathe contains several patented features which the company claims are not found on any other lathe on the market.

A New Departure in Primary Cells.

The use of peroxide of lead in a primary cell is a new departure, and while it has long been used in connection with storage batteries, its successful application in a primary battery is not recorded. The Harrison cell made by Harrison Brothers & Co., Incorporated, Philadelphia, Pa., embodies the use of elements of lead peroxide and zinc amalgam, with dilute sulphuric acid as the electrolyte. This combination gives, it is stated, a maximum eletromotive force of 2.45 volts. The quick depolarization obtained by the use of specially prepared lead peroxide, together with the low resistance of the electrolyte, it is claimed, renders the Harrison cell, with its high voltage, the most powerful open-circuit cell yet devised. The recuperative powers of the cell are great, and it will accomplish an extraordinary amount of work, taking into consideration its size. The cell is 5 inches high by 3 inches square, and its compactness is one of its commendable and important features, since it occupies only a fraction of the space required for the usual type of open-circuit wet cell.

The practical meaning of the high voltage of the Harrison cell is that a battery of half the number of cells of the wet-cell type will give the same pressure. The cell is clean and free from the annoyances incident to creeping salts, etc., and it is stated that it will not freeze in cold weather. It is estimated that the cost of the energy obtained from this cell is about 1 cent per watt-hour. The cell will give, on ordinary open-circuit work, a discharge of 40 ampere-hours, of over 80 watt-hours. As compared with other open-circuit cells, it is pointed out that the cost of the total energy of the Harrison No. 1 cell is equivalent to one-third of that of other cells. Therefore, the manufacturers claim that their cell is the cheapest, most compact and generally satisfactory ever offered to the public.

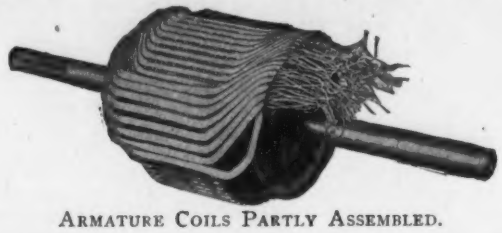
The cell is adapted for all kinds of open-circuit work, and, it is said, does not deteriorate when standing idle, since there is no local action. When it grows weak the negative element or lead peroxide stick is replaced with a new one. The positive or zinc element generally outlasts two peroxide sticks, and when it is consumed a new element can be substituted in the same way.

The Thermo-Electric Company, "Times" Building, New York, is the sole agent for this battery.

A New G. E. Direct-Current Stationary Motor.

To meet a demand for larger direct-current stationary motors, the General Electric Company has perfected a line of motors known as the type C. E. These embody all the features of excellence characteristic of other General Electric motors, as well as the latest ideas in motor construction. Their design is such that they may readily be modified to meet special requirements.

The motor frame, which is also the magnet yoke, is of soft steel cast in the form of a hollow cylinder with projecting foot on the outside and seats for the pole pieces on the inside. The short magnetic circuit which this arrangement



ARMATURE COILS PARTLY ASSEMBLED.

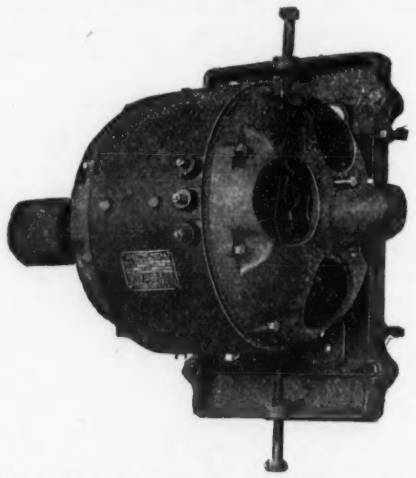
gives and the use of the best material contribute to make the new motor efficient in all its capacities. The pole pieces are built up of iron laminations, and are secured to the yoke by through bolts with nuts on the outside. The field coils are held in place by the extended lips of the pole pieces, and as the face of the pole piece covers a large surface of the armature, without increasing the size of the field coils, the efficiency of the motor is materially augmented.

The armature is built up in the usual manner of iron laminations, with provision for ample ventilation. The coils are placed in the core slots, the ends of the coils lying along the flanges. This arrangement provides a large ventilating surface for the conductors and reduces the length of wire necessary with consequent decreased resistance. The coils are securely held in a rigid position, and injury to the insulation from sliding or vibration is impossible.

The commutator and brush holders are of the types used with G. E. railway motors. The armature loads are soldered into slots in the segments, and being short are not liable to become displaced and, abrading the insulation, cause a short circuit. The brush holders are of cast brass arranged for radial carbon brushes, which slide in finished ways and are pressed against the commutator by independent pressure fingers, giving uniform pressure throughout the life of the brush. There is no sparking, and change from no load to full load requires no shifting of the brushes.

The bearings are supported by cast iron end shields. This method of support is lighter, but not less rigid, than pillow blocks, and, while affording protection to the working parts, does not lessen the compactness of the motor. Furthermore, the motor being symmetrical, a simple quarter or half turn of the end shields allows it to be fastened to a wall or be suspended from the ceiling. The end shields have hand holes which provide ventilation and give easy access to the working parts. In motors intended for use in dusty places these hand holes may be covered by wire screens which offer little resistance to the air, and for continuous service are superior to solid covers. The bearings have ample surface and are automatically lubricated. The linings are of gun metal in one piece, and rest on the bearings throughout their entire length.

In the motors under consideration the four-pole construction has been adopted for all sizes down to and including the 3-hp slow-speed motor. By the adoption of this construction, the use of a steel magnet yoke, and the use of end shields to support the bearings, an economy of material is effected which permits, without sacrifice of strength or stability, of the construction of motors



TYPE C. E. MOTOR, WALL SUSPENSION.

much lighter for a given output than other machines running at even higher speeds. The magnetic material is economically arranged, the machines are light and compact, the centre of gravity is low and the floor space occupied is small.

The C. E. motors are built in capacities of from 2 horse power to 10 horse power in slow speeds, and from 3 horse power to 15 horse power in moderate speeds. They are conservatively rated, and it is stated will run under full load at an unusually low temperature. The standard type will deliver the rated output continuously without rising in temperature above 40° C. above the surrounding air. With the wire screens over the hand holes this will be slightly exceeded. The motors will carry a temporary overload of 40 per cent. without injurious heating. Following its usual practice the General Electric Company makes all parts of these motors to gauge, and duplicate parts can thus be obtained without delay.

Financial Intelligence.

THE BUFFALO GENERAL ELECTRIC COMPANY, by the action of its stockholders on February 1, will give a mortgage on its property to secure $2,400,000 5 per cent., forty-year bonds, to be issued in lieu of the corporation's present bonds, pursuant to the plant adopted for the refunding of the present bonded indebtedness.

THE ASTORIA LIGHT, HEAT & POWER COMPANY has filed a mortgage for $500,000 with the Queens County clerk in favor of the Union Trust Company as trustee. The mortgage is given as security of an issue of $500,000 fifty-year 5 per cent. gold bonds. The money is to be used in the development of the business of the new company. The company's plans, as far as they have been made public, were referred to in the last issue and in previous issues of THE ELECTRICAL WORLD.

DIVIDENDS OF THE GORDON BATTERY COMPANY.—The directors of the Gordon Battery Company, 594 Broadway, New York, at a special meeting on January 18 decided that the earnings of the company for the first six months of the fiscal year were sufficient to permit the payment of a 4 per cent. dividend on the preferred stock outstanding, and declared that such dividend be paid to preferred stockholders of record on February 20. The transfer books closed on February 8, and will be reopened on February 20, when the dividend checks will be mailed to stockholders.

METROPOLITAN STREET RAILWAY was a prominent feature on the New York Stock Exchange on February 3. Early in the day it declined 2 points, and afterwards took an upward leap, landing at a point where it showed a net gain of 8¼ per cent. on the day's transactions. The upward movement was coincident with a report that the company had acquired control of the Third Avenue surface railroad. It is, however, thought that a more substantial reason for the activity may be found in the development of the company's plans with reference to the supply of current for light, heat and power for use outside of its own demands.

THE BALTIMORE RAILWAYS & ELECTRIC LIGHT COMPANY.—The financial plan of this company, which is in virtual possession of the Baltimore lighting and railway interests, as noted in the railway columns of last issue, and in the electric light column of this issue, provides for a total capitalization of $76,000,000 in stocks and bonds. Of this amount $38,000,000 will be 4 per cent., fifty-year gold bonds, $14,000,000 preferred cumulative 4 per cent., and $24,000,000 common stock. Of the $38,000,000 issue of bonds, $10,500,000 will be reserved in the treasury for underlying bonds of the Consolidated Railway; $3,800,000 for underlying bonds of the City Passenger Railway; $1,250,000 for underlying bonds of the Baltimore & Northern Railway; $4,450,000 to pay for acquisitions, improvements, etc.; $9,600,000 to pay for Consolidated stock at $24 a share; $8,400,000 to pay for City Passenger stock at $60 a share. Of the $14,000,000 preferred cumulative stock $7,350,000 will be used to pay for the Consolidated stock and $6,650,000 to pay for City Passenger stock. Of the $24,000,000 common stock $11,000,000 will be retained in the treasury to be used as necessities arise, $8,000,000 for subscribers in the shape of a bonus of 25 per cent., and $5,000,000 to pay for the stock of the Baltimore & Northern and Middle River railways. The organization of the company, which will operate the 350 miles of railways in and about Baltimore, will be completed in the course of a week or two.

Special Correspondence.

NEW YORK NOTES.

TO THE EGYPTIAN PYRAMIDS IN AMERICAN CARS.—The Westinghouse Electric & Manufacturing Company has received an order for electric railway equipment to be used in carrying tourists to and from the pyramids in Egypt. The road is to be built by English capital, and will run from Cairo to the pyramids.

REGULATION OF AUTO-TRUCKS.—A resolution was introduced into the Council a few days ago directing the president to appoint a committee of five to draft an ordinance regulating the speed of motor carriages and trucks, fixing the license fee for their operation and making provisions for examination and certification of the drivers. The matter was referred to the Law Committee.

MORE ELECTRICAL HANSOMS AND BROUGHAMS.—The directors of the Electric Vehicle Company at a recent meeting voted to establish two more stations in this city, each to be equipped with one hundred vehicles. The station now in service is planned for the same number, and has now sixty vehicles in use. The demand for these is so great that the company feels warranted in authorizing the extension above noted.

BANQUETS OF THE ALUMNI OF ENGINEERING INSTITUTIONS.—On Saturday evening, February 4, the New York branch of the Alumni Association of the Massachusetts Institute of Technology held its annual banquet at Sherry's, with an attendance of sixty. The evening before the New York branch of the Alumni Association of the Worcester Polytechnic held its first annual banquet. There were about forty persons in attendance.

THE SPRAGUE CLUB.—The employees of the Sprague electric elevator works at Watsessing, N. J., have formed an organization known as the "Sprague Club," the object of which is to promote physical, social and moral culture among the members. The club house will be equipped with a gymnasium and a library. It is stated that the idea originated with Mrs. F. A. Scheffler, wife of the general manager of the works, and that Mr. Sprague is heartily in favor of the club.

CHARGES FOR THE USE OF UNDERGROUND CONDUITS—If a resolution which was introduced in the City Council a few days ago becomes a law any corporation organized hereafter to furnish telephones, electric light, gas or heat through any conduit laid or to be laid in the public streets will be compelled to pay 40 cents for each lineal foot of conduit laid or used. It is stated that this resolution is aimed principally at the People's Telephone Corporation. It was referred to the Railroad Committee.

MESSRS. PLATT AND CROKER AS TELEPHONE PROMOTERS.—The New York "World" is responsible for the statement that Messrs. T. C. Platt and Richard Croker are organizing a $5,000,000 telephone company in opposition to the Bell interests in this city. According to the report, the rates to be charged will be $75 for the same service for which the older company now charges $240 per annum. It is also stated that the new company will co-operate with 3000 independent companies throughout the country.

FINING THE NASSAU RAILROAD COMPANY.—An order has been entered in the clerk's office of the United States Circuit Court fining the Nassau Electric Railroad Company, of Brooklyn Borough, $1825 for contempt in violation of an injunction issued in the suit of the Sprague Electric Railway & Motor Company against the Nassau Company for infringement of patents. The order for this fine was issued by Judge Lacombe, and was referred to in the Legal Notes in the last issue of THE ELECTRICAL WORLD.

TRACTION MEN IN TOBACCO.—Several of the gentlemen who are members of the electric railway syndicate which is interested in the street railways in Philadelphia, New York and other cities are now turning their attention to the tobacco interests. A certificate of consolidation of the Union Tobacco Company of America and the North American Commercial Company has been filed at Albany. Among the directors are Thomas F. Ryan, of New York City; P. A. B. Widener and William L. Elkins, of Philadelphia. The name of the new company is the Union Tobacco Company of America.

THE NEW YORK ELECTRICAL SOCIETY will hold its 194th meeting at the station of the Electric Vehicle Company, 1684 Broadway, on Tuesday evening, February 14, at 8 o'clock. Mr. G. Herbert Condict, the electrical engineer of the company, will give an informal talk on the status of the automobile and its future development and use. The members will afterward visit the various departments of the establishment. It is requested that each member intending to be present inform the secretary to that effect not later than Saturday, February 11, stating at the same time whether or not he expects to be accompanied by a lady. It is proposed to issue special tickets of admission, and no one will be admitted to the building without a ticket.

THE COMBINATION OF ELECTRIC AND GAS FIXTURE INTERESTS.—In THE ELECTRICAL WORLD of January 21 reference was made to the proposed combination of manufacturers of gas and electric fixtures and fittings in the United States. In this connection it is now stated that twenty-four of the largest concerns in this line have expressed their willingness to become members of the combination. It is reported that the W. C. Vosburgh Manufacturing Company, of Brooklyn, may be sold to the promoters of the trust, and various Manhattan concerns will become part of the trust property within a short time. The twenty-four companies which are interested in the deal are located in Brooklyn and Manhattan boroughs, New York City; Philadelphia, Cleveland, Chicago and San Francisco.

THE FIFTH AVENUE AUTOMOBILES.—It is stated that the substitution of automobiles for the present lumbering vehicles on the Fifth Avenue stage line will soon be accomplished. Dr. Louis Duncan, consulting engineer for the Fifth Avenue Company, is reported to have said that it has not yet been decided which system of propulsion shall be used on the new equipment. There are many points to be considered in making a choice. The great objection to electric vehicles, for instance, is the great weight of the storage batteries, and, on the other hand, the odor in connection with petroleum or gasoline motors is a great objection. Compressed air, he said, would be the ideal power, but air automobiles have not as yet reached that development where they could be successfully used. He stated that a choice would probably be made in two or three months. About twenty manufacturers of automobile vehicles are preparing specifications.

REORGANIZATION OF THE BROOKLYN ELEVATED ROADS.—The Brooklyn Union Elevated Railroad Company was incorporated at Albany on January 30, with a capital of $18,000,000. Of this amount $13,000,000 is common and $5,000,000 preferred stock. The preferred will be entitled to a non-cumulative dividend annually before anything is paid on the common stock. It is stated that as soon as the receiver of the Brooklyn Elevated Railroad Company is discharged the new company will take possession of the property. The next step will probably be the renewal of the negotiations looking to the absorption of the road by the Brooklyn Rapid Transit Company. The directors of the new company are Frederic P. Olcott, James T. Woodward, Charles Parsons, Ernest Thalmann, Leonard Lewisohn, Frederick Uhlmann, Simon Uhlmann, Edward Lauterbach, Henry Sidenberg, Emil Schaefer, Simon Rothschild, William Halls, Jr., and George W. Wingate.

COMBINATION OF ENGINE BUILDERS.—It is stated that representatives of eight of the largest engine-building companies in the country met in this city the latter part of this week to effect a combination of their plants. The first step in this direction was taken in Providence a week ago, when the

Corliss Steam Engine Works of that city was acquired by the capitalists interested in the combination. The Wheelock & Greene Works, of Worcester, Mass., it is reported, have also been purchased. It is expected to bring into the combination twelve of the leading engine works of the country. The president of the new company is Colonel D. M. Thompson, of Providence, and the directors will include Edwin S. Cramp, president of the Wheelock & Greene Works; Lewis Nixon; W. H. Knight, chief engineer of the American Air Power Company, and Charles A. Lieb. The main plant of the company, it is stated, will be either in this State or in New Jersey, and the company will be capitalized at about $20,000,000. It is reported that $1,000,000 was paid for the Corliss Works.

ELECTROLYSIS OF WATER PIPES IN BROOKLYN.—On December 11 last a four-foot water-main in the eastern section of Brooklyn Borough burst, doing much damage to surrounding property and depriving a large area of that section of the city of its water supply. At the time it was reported that the cause of the break was a defective casting. It has, however, been ascertained, according to information received by the "Engineering News," of this city, that the real cause of the collapse was the weakening of the pipe by electrolysis. The evidence in support of this assertion, it is stated, was unquestionable. The place where the break occurred is in the vicinity of a railway power-house, and it is generally understood that currents from the electric railway's return circuits are found in the water mains in many parts of Brooklyn. In a recent communication to the executive committee of the National Board of Fire Underwriters an engineer of the board reports that he was informed by an employee of the waterworks in Brooklyn that one of the companies was absolutely using a 6-inch water-main as its return circuit.

THE ASTORIA LIGHT, HEAT & POWER COMPANY, of Queens County, is looming up as an interesting factor in the electric lighting situation in Greater New York. A bill was introduced in the Assembly at Albany on February 2 having for its object the granting of authority to the company to supply gas and electricity to New York City. Conductors, mains and pipes may be laid under and across the East River. The company may supply gas and electricity to any other company or companies engaged in a similar business, and may lease the property of any such other company. It is explained that the object of the bill is to allow the Astoria Company, which has a valuable plant in New York City, to go out of the city with its plant and conduit, by pipes and conduits, gas and electricity to the city the same as if they were manufactured in the city.

ELECTRICITY ON THE ELEVATED ROAD.—It is stated that the Executive Committee of the Board of Directors of the Manhattan Railway Company, at its meeting on February 1, gave President Gould full authority to finance the electrical equipment of the elevated railway system. It is thought that the necessary funds will be obtained by an issue of new stock. It is not yet known whether any particular system of electric traction has been chosen, but it is stated that practical tests will be made shortly of the various systems that have been brought to the attention of the company. It is announced that Messrs. Kuhn, Loeb & Co. have undertaken to underwrite the authorized issue of $18,000,000 of new Manhattan railway stock, and to take all of the stock of the issue which is not subscribed for by the present stockholders. This will assure the management of the road the possession of the money for the new stock as soon as it could be called for under any contracts that might be made for the electrical equipment. The old stockholders will each be entitled to subscribe for 60 per cent. of their present holdings of new stock at par. There seems to be an impression in financial circles that electric power will undoubtedly be selected. Compressed air has been talked of, but it is pointed out that the various tests that have been made with compressed air cars have not been successful. It has been calculated that the electrical equipment of the elevated roads would require about 70,000 horse power, and that it would cost $10,000,000 or $12,000,000. The new issue of stock will amply provide for this and leave a margin for any betterments of the line or rolling stock which may be needed. It is reported that a special meeting of the Manhattan directors will be held on March 1 to take action on plans for financing the electrical equipment. Mr. George Gould, on Monday last, made some definite statements on the general subject of electric power, which seem to indicate that the officials of the Manhattan Elevated Railway Company are giving the subject their earnest and serious attention. Mr. Gould's utterances on the subject heretofore have not always been very definite, but in this instance he has unbosomed himself to an extraordinary extent. He says: "The public has very little idea how thoroughly the management of the elevated roads has investigated the subject of electrical power. The investigations which have been conducted during the past year relative to a change of motive power have embraced the generation, distribution and use of electrical power on both elevated and surface roads by every important plant in this country, particularly those in New York, Brooklyn and Chicago. The most careful and conservative estimates made by experts," he says, "show a saving of 2½ cents a mile on the entire car mileage made on the elevated roads." Continuing, he said: "As we are now running over forty million car-miles per year, the saving in operating expenses alone will be over $1,000,000 per year, which, with other economies possible, is sufficient to pay 5 per cent. on the new capital which it is proposed to the stockholders to put into the elevated roads, and 1 per cent. additional on the present capital; in other words, to put the whole property on a sound 5 per cent. basis. * * * The increase in speed will be from 16 to 18 per cent., and the increase in capacity of our trains during rush hours will be 20 per cent., enabling the company to handle its traffic in very much better shape. During those hours of the day when traffic is light our trains now run on some of the lines on a six-minute headway. The application of electricity will enable us to run cars without any additional expense on a headway of a minute and a half. * * * The management of the road, too, will be greatly aided by the ease with which our trains will be handled at the terminal points. There will be no locomotives to stop for water or fuel. The trains can run in and out again immediately without any delay except the necessity of loading and unloading their passengers. * * * Another possibility that the introduction of electricity will give to the public will be the use of open cars in the summer time. The issue of the $18,000,000 additional stock, which will be offered to our stockholders at par," he said, in conclusion, "will provide not only for the substitution of electric motive power, but for new plant and equipment, the modernizing of all facilities for the comfort and convenience of the public, thereby increasing the efficiency and economy of the service, as well as the net earning capacity of the system. Any surplus from the $18,000,000 can be used by the company for the enlargement and improvement of its property."

New England Notes.

MORE SUBWAY FOR BOSTON.—Senator Innis presented in the State Senate, on February 1, the petition of Josiah Quincy, Mayor of Boston, asking for an extensive addition to the Subway. The petition asks for the construction of a subway in Boston from a point on Washington Street or Harrison Avenue to a point north of the tracks of the Boston & Albany Railroad, then to a point near the Northern Union Station on Causeway Street and in the vicinity of the new Charlestown bridge, with connections between the new Southern Union Station and the present subway.

CHANGE IN THE OWNERSHIP OF THE LOWELL ELECTRIC LIGHT COMPANY.—The ownership of the Lowell (Mass.) Electric Light Corporation changed hands on February 1. Messrs. Stone and Webster, electrical engineers, of Boston, representing a syndicate, purchased 1800 of the 3000 shares of the company at par. The following board of directors, who will represent for the present the interests of the purchasers, were chosen: F. R. Hart and W. C. Forbes, of Milton; E. S. Webster, C. A. Stone and L. J. Webster, of Newton, and Edward Wadsworth and L. W. Lee, of Boston. William H. Bent, of Lowell, was chosen clerk and treasurer.

THE COMMITTEE ON STREET RAILWAYS of the Massachusetts Legislature has been receiving the past week testimony in favor of the restoration of the electric car tracks on Tremont Street, which by an act of the Legislature were removed on the opening of the Subway. The arguments for the replacing of the tracks appear to be forcible and convincing, and those who presented them represent the business interests and the public. They demonstrated quite conclusively the present congestion of the Subway and Washington Street, and that public sentiment calls for the relaying of the tracks, at least until the completion of the elevated railway.

MR. C. R. FISH, the electrical supply dealer, is now housed in his new quarters at 71 and 73 Broad Street, Boston, where he has a neatly arranged office and spacious storeroom for carrying all kinds of electrical specialties, with excellent facilities for quick shipments. Mr. Fish is doing a nice business, which is not at all surprising in view of his large circle of friends among central stations, isolated plants and supply houses. Mr. Fish has had long experience as a practical station manager and in the electrical business, first in the early days with the Thomson-Houston Electric Company and General Electric Company, and latterly with the Fort Wayne Company.

THE FRANK RIDLON COMPANY EXTENDING ITS BUSINESS.—Mr. Charles N. Wood has been elected a director and vice-president of the Frank Ridlon Company, Boston. Mr. Wood brings to the Frank Ridlon Company agencies that he has controlled in New England for several years past for the R. D. Nuttall Company, International Register Company, the Bradford Belting Company, the American Electric Heating Corporation and other concerns. It is the intention of the Ridlon Company to establish under Mr. Wood's management a street railway supply business, and the company is now in a position to fill orders in this line. Its facilities for doing repair work and rewinding armatures are the very best. For the present Mr. Wood will continue his office at 31 State Street, but as soon as the company can obtain more commodious offices, of which it has a lease at 200 Summer Street, the business will be consolidated in one office.

CONVENTION OF MUNICIPAL ELECTRICIANS.—The Executive Committee of the International Association of Fire and Police Superintendents and Municipal Electricians met in Boston recently. The object of the meeting was to amend the constitution and by-laws and to arrange for the convention at Wilmington, Del., on September 5 next. The name of the association was changed to "The American Association of Municipal Electricians." It was also voted to enlarge the membership so as to include any person engaged in electrical work. The following papers will be presented at the next meeting: "The Laws and Government Pertaining to the Boston Wire Department," Wire Commissioner Thomas W. Flood; "Police Signal System of Boston," Superintendent John Weigil, of Boston; "Licensing of Employees on Electrical Work, and Improving the Quality of Work and Material," Capt. William Brophy, of Boston; "Underground System as Applied to Fire Alarm Telegraphy," Superintendent S. L. Wheeler, of Springfield; "Advisability of Concentrating the Control of all Municipal Interests Under One Head," Superintendent Morris W. Mead, of Pittsburg; "Progress and Development of the Municipal Electrical Interest of Canada," Superintendent G. F. McDonald, of Ottawa. In connection with the next meeting of the association will be held an exhibition of electrical and mechanical apparatus used in various departments of municipal work, which, it is thought, will be very interesting and instructive. A large building has been secured for this purpose, and every facility will be afforded manufacturers to attractively display their goods. Ample power will be supplied for operative exhibits and a special committee will be appointed by the association to make a report on the exhibits. Among the displays will be one showing the various stages of progress in the municipal fire-alarm business down to the present time. The Montauk Multiphase Cable Company, of New York, will make an exhibition of its cable in connection with all interior adaptations, including telephone, district call boxes, watchmen's time detector service, electric lights and Gamewell auxiliary fire-alarm boxes in circuit therewith. The various insulating wire companies will make a display of their products.

Buffalo and Western New York Notes.

THE PROPOSED PLANT ON THE CANADIAN SIDE.—On Saturday, February 4, the officers of the Niagara Falls Power Company are to have a conference at Toronto with officials of the Dominion regarding plans for and the construction of the proposed new plant on the Canadian side of the river.

ROCHESTER & SODUS BAY RAILWAY.—The State Board of Railway Commissioners has granted the application of the Rochester & Sodus Bay Railway for permission to construct an electric line from Rochester to Sodus Point, on Lake Ontario, a distance of 42 miles. The New York Central opposed this application on the ground that the new road would parallel the Rome, Watertown & Ogdensburg road, and that there was not sufficient traffic to warrant the double lines. The board decides that in its opinion there is sufficient traffic for the new road without disturbing the rights and patronage of the steam road.

NIAGARA FALLS WATER POWER.—Although there has been a great deal of ice going down the Niagara River at various times during the present winter the water-power plants on the New York side have suffered no serious inconvenience therefrom. It has been necessary to keep men at the outer gates clearing floating ice with rakes from time to time, but the downward current in the penstocks of either of the large plants is not rapid enough to suck down any ice which may get into the forebay, and such ice is taken out from above with dip nets. The plant on the Canadian side, which runs the Niagara Falls Park & River Railway and other power users was, during the latter part of January, severely hampered by floating ice and once shut down for several hours, so that the water supply pumps of the city stopped and a line of hose was stretched across the arch bridge to take water from the pipes of Niagara Falls, N. Y., during the stoppage.

PAN-AMERICAN EXPOSITION.—Subscriptions to the capital stock of the Pan-American Exposition reached the sum of $1,308,000 on Saturday February 4, after being open only two weeks, and no considerable amount taken from other than Buffalo people. On the evening of Saturday, January 28, at which date the amount subscribed was $1,114,000, the chairman of the finance committee, Mr. Henry W. Sprague, of Moot, Sprague, Brownell & Marcy, general and special counsel for the Erie Railroad Company and the Erie County Savings Bank and other large interests, made a statement concerning the reliability of the subscriptions. Mr. Sprague said that he, together with the managers of the two leading banks in Buffalo, had examined the list of all subscribers of $2000 or more, amounting them to over $750,000, and found only $17,000 thereof subscribed by persons whose paper would be questioned by any Buffalo bank, and the paper of these subscribers is undoubtedly collectible. During the past week a committee of prominent citizens has been in Washington to present to Congress the request for an appropriation for a Federal exhibit, and has been most favorably received by the President and the members of the Ways and Means Committee, which has the bill under consideration. The entire New York Congressional delegation is strongly in favor of the appropriation of $500,000 asked for.

CHICAGO NOTES.

MR. ARNOLD'S GENIUS RECOGNIZED.—Mr. Bion J. Arnold, the well-known consulting electrical engineer, of Chicago, has within the past few days received a gold medal and diploma from the Omaha Exposition. He secured this mark of excellence through his personal exhibit of mechanical and electrical designs, which occupied a place in the Electrical Building. The exhibit consisted of a chronological display of Mr. Arnold's achievements in mechanics since boyhood, starting with a model of a small steam engine made when he was sixteen years of age, and ending with the plans for the Chicago & Milwaukee Street Railroad of recent date.

THE ILLINOIS TELEGRAPH & TELEPHONE COMPANY.—It is stated that the principal promoters of the Illinois Telegraph & Telephone Company, which has received a franchise to conduct business in this city, are Milo G. Kellogg and H. J. Hanford. Mr. Hanford, it is stated, is the promoter and builder of the "outside" telephone exchanges in St. Louis, Cleveland and Indianapolis. He is reported to have said that all arrangements have been completed to finance the company, and that $500,000 of the stock will be subscribed for in Chicago. The rest will be taken partly in St. Louis and partly in other cities. The stock of the Illinois Company will be placed in the hands of a trustee to remain for five years. As soon as the ordinance becomes a law offices will be opened and the company's engineers will at once begin work on plans and drawings. The company expects to begin construction work in three months, but the enterprise is one of such magnitude that there scarcely can be any extensive connections inside of two years.

OVERHEAD TROLLEY ORDINANCE.—On the night of January 30 an ordinance allowing the three principal street railway companies of Chicago to use the overhead electric system on their horse and cable lines was favorably reported from the Chicago City Council Joint Committee on Streets and Alleys, North, South and West. It is believed to be certain of passage. Mayor Harrison has stated that he will veto the ordinance, but many of the aldermen declare that there will be votes enough to pass it over his veto. If it finally becomes a law it will doubtless cause the ultimate abandonment of the cable lines now operated in Chicago, and will permit the use of the overhead wire throughout the downtown district. The ordinance for the overhead trolley is the latest move in the street railroad fight which has been going on in Chicago for several months. It was called forth by Mayor Harrison's letters to the street railway companies complaining of crowded cars and insufficient accommodations for the public on the cable lines. The letters were replied to by President M. K. Bowen, of the South Side lines, and President Charles T. Yerkes, of the North and West Side lines, stating that the use of the trolley would furnish a ready solution of the troubles mentioned. Mr. Yerkes followed up his letter by a communication to the City Council, in which he reviewed the controversy regarding crowded cars, and asked the passage of an accompanying ordinance for the overhead trolley system, The matter was referred to the Joint Streets and Alleys Committees, which held two sessions, at one of which Mr. Yerkes and others spoke. The question of the feasibility of the underground-conduit system in Chicago was extensively discussed. Mr. Yerkes stated that the insufficient drainage of the city streets made its use an impossibility, and gave the history of the experimental line which he built a few years ago on the North Side as proof. The general opinion of the best-posted engineers in Chicago is that the small elevation of the city level above the river and lake prevents the city from ever having drainage sufficiently good to permit the successful operation of a conduit road.

INDIANA NOTES.

TELEPHONE CHARGES.—A bill has been introduced in the Legislature providing that the charges by any telephone company shall not exceed $2.50 a month for business houses and $1.50 a month for residences.

NEW CHARTERS WANTED.—Terre Haute, Evansville and Fort Wayne are each asking the Legislature for a new charter. The principal purpose is to obtain facilities for better electric light, street railways and fire protection.

NEW ELECTRIC LINE PROJECTED.—Richmond (Ind.) capitalists have filed articles of incorporation of the Cambridge City International Traction Company, with a capital stock of $150,000. An electric line is to be built from Cambridge City to Hagerstown by way of Milton, Dublin and East Germantown.

THE FORT WAYNE ELECTRICAL MANUFACTURING COMPANY was organized at Fort Wayne, Ind., on January 27, with a paid-in capital of $250,000. The stock is all subscribed by Fort Wayne capitalists. It is the purpose of the company to purchase the plant of the Fort Wayne Electric Corporation, and it is stated that the deal has been practically closed.

NO SEAT NO FARE.—An ordinance has been introduced in the Council at Indianapolis prohibiting any street car company or employee from demanding a fare of a passenger to whom a seat cannot be given in the car. For any violation of the ordinance a fine of not more than $25 is provided for each separate offence. The ordinance is intended to permit those who are forced to stand in street cars to ride without paying fare.

COMPETITION FOR A NEW CONTRACT.—The franchise of the Franklin Light & Power Company for lighting the streets of Franklin with electricity is about to expire. There is great competition for the new contract. Chicago capitalists are on the ground preparing to put in an incandescent plant. They have prepared a franchise to cover both systems, and are making a preliminary canvass for subscribers to incandescent lights.

TO SET MORTGAGE ASIDE.—The unsecured creditors of the Fort Wayne Electric Corporation, by P. A. Randall, have filed a suit to have the $250,000 mortgage given in the General Electric Company set aside. They allege that the late R. T. McDonald executed this mortgage in the General Electric concern to secure a personal obligation, and that he had no right to make the corporation responsible for his personal obligations. Since the mortgage was executed there have been two reorganizations of the corporation, and the legal complications are somewhat tangled.

PROCEEDINGS IN BANKRUPTCY have been taken in the United States District Court against the Fort Wayne Electric Corporation, of Fort Wayne, by the attorneys of Holmes, Booth & Haydens, of New York, and the American Electrical Works, Providence, R. I., and other creditors, holding claims aggregating $50,000. The petition alleges that the company has committed acts of bankruptcy in preferring certain creditors while it was solvent. It is stated that the indebtedness of the Fort Wayne Electric Corporation aggregates $900,000, and that the probable assets are $350,000.

A FIFTY-YEAR FRANCHISE.—The Commissioners of Marion County, on January 28, granted a fifty-year franchise for an electric railway in the national road, east from Irvington to the county limits, to the Indianapolis, Greenfield & Eastern Electric Railroad Company. This company is a consolidation of an organization which has a franchise in Hancock County, with two Indianapolis companies promoted by Messrs. Morris, Cooper & Webster. The fare to be charged passengers is not to be less than 5 cents in any event. The maximum charge between Irvington and Greenfield (20 miles) and return is not to exceed 50 cents, and a proportionate rate from other points. Freight rates are not to exceed 50 per cent. of those of steam railroad companies. The road is to be constructed and in running operation by January 1, 1900.

A NEW HEARING GRANTED.—The Indiana Supreme Court has granted a rehearing in the celebrated franchise contention between the City Street Railway Company and the Citizens' Street Railway Company. The decision was to the effect that the Citizens' Street Railway Company's franchise expired in 1901, and that the City Company's franchise was good for thirty years. Two of the judges dissented, holding that the former company's rights extended to 1901, but that the City Company had obtained no rights to the streets whatever. The three majority judges have since gone off the bench, and the three successors joined the dissenting judges in the granting of a new hearing. This is equivalent to holding that the City Company has no rights, and that Indianapolis will have a franchise to sell to the best bidder in 1901.

IN THE HANDS OF A RECEIVER.—The Indianapolis & Broad Ripple Street Railway Company has been by order of court, on petition of the State Bank of Indiana, placed in the hands of John B. Cockrum as receiver. The petition set out that the company, by the late Ronald T. McDonald, issued its notes to the bank for various large sums of money. The judgments thus far confessed amount to $13,000. Since the death of Mr. McDonald it has been known that the affairs of the company were in a very bad or muddled condition, and the suit, judgment and appointment of a receiver was no surprise to the community. There are other large creditors. The road is alleged to have been capitalized for $400,000. It is also rumored that a number of McDonald's personal notes are outstanding secured by the notes of the company as collateral security aggregating close to one million dollars.

PACIFIC COAST NOTES.

THE SUNSET TELEPHONE line, connecting Portland and Astoria, Oregon, is now in course of construction. The copper wire will be strung on the poles of the Postal Telegraph & Cable Company for the greater part of the distance.

ELECTRIC TRAINS TO THE CLIFF HOUSE.—The Market Street Railway Company, San Francisco, recently commenced hauling Sunday electric

trains to the Cliff House beach. Three standard coaches were successfully handled by a 40-foot electric motor car. The old Metropolitan power station is put into operation on Sundays, as the end of the line is a long distance from the company's central electric power house.

A PROJECTED 35-MILE TRANSMISSION PLANT.—The Seattle Power Company, of Seattle, Wash., has come to the front again, and proposes to construct as soon as possible an electric transmission plant at the Falls of Cedar River. The distance to Seattle is 35 miles by wagon road, but much less by an air line. The river falls 600 feet, in a series of cataracts, in a distance of 1½ miles. The capacity of the plant will be 12,000 horse power. President E. H. Amidown, who recently returned from the East, is said to have interested Eastern and foreign capital in the enterprise.

AN 81-MILE TRANSMISSION LINE IN SUCCESSFUL OPERATION.—The Southern California Power Company commenced transmitting current over its 81-mile transmission line to Los Angeles, Cal., on January 24. It is said to be the longest electric transmission in the world. General Electric 3-phase generators are used, direct connected to water wheels. The line potential is 33,000 volts. After 48 hours of operation it was decided that the system was a success in every particular. The generating station is located on the head waters of the Santa Ana River. Messrs. Fisher and Sinclair, of the Redlands (Cal.) Power Company, are at the head of the new system, with O. H. Ensign as electrical engineer. The water supply is not likely to be affected by drouth.

THE PROPOSED MUNICIPAL PLANT FOR SAN FRANCISCO.—This is the San Francisco Supervisors' resolution in favor of a municipal electric light plant: That it is the sense of this board that the city and county of San Francisco should construct a plant capable of furnishing electric lights for the streets and also for the lighting of the public buildings, and that arc lights should also be supplied to merchants, business men and property owners at actual cost whenever demanded. The Mayor was authorized by resolution to employ an expert to report on the cost, together with a plan for construction of a plant of sufficient capacity for the purposes stated above. It was stated at the recent meeting, when the resolution was passed, that San Francisco is paying $165 per arc light per annum. Mayor Phelan informed the Supervisors that while the city paid 55 cents per night for each arc light, Golden Gate Park, which has its own electric lighting plant, is lighted at a cost of 27 cents per arc light per night.

Canadian Notes.

ELECTRIC MINE HAULAGE.—The Dominion Coal Company, of Cape Breton, in the province of Nova Scotia, purposes to adopt electricity for hauling purposes in its mining operations.

AN ELECTRIC RAILWAY TO NEPIGON LAKE.—Mr. T. A. Gorman, of Port Arthur, Ont., will ask the Ontario Legislature for a charter for an electric railway from Nepigon Station, on the Canadian Pacific Railway, to Nepigon Lake.

THE HAMILTON-GUELPH ELECTRIC RAILWAY.—It is understood that the Cataract Power Company, of Hamilton, Ont., will very soon make a survey of a definite route for the proposed electric railway from Hamilton to the cities of Galt, Berlin and Guelph, Ont., with a view to the commencement of building operations in the spring.

WATER POWER FROM CANALS.—Three deputations were in Ottawa recently from Morrisburg, Peterboro and Lindsay, Ont., each asking the Government to permit the drawing of water from the public canals to be utilized as power. Lindsay and Peterboro ask to be allowed to draw a limited supply from the Trent Canal. The Morrisburg town corporation requests permission to draw a head of 12 feet from the Morrisburg Canal to enable the corporation to supply electric light and power.

ELECTRICAL DEVELOPMENT IN HALIFAX.—The Electric Tramway Company, of Halifax, Nova Scotia, has increased its capacity recently to a large extent, as well as the track and overhead equipment of its road. In its power station a large quantity of new machinery has been put in, including the latest type alternating machines, rotary transformers and tandem compound engines. Alternating enclosed arc lights have been introduced throughout the city of Halifax, and there are also great many motors for manufacturing and elevator purposes.

English Note.

SUCCESSORS TO DR. JOHN HOPKINSON.—The electrical engineering practice of the late Dr. John Hopkinson has been taken up by a partnership of his brother, Charles Hopkinson; his son, Bertram Hopkinson, and Mr. E. Talbot, with offices at 26 Victoria Street, London.

General News.

New Incorporations.

THE CORUNNA LIGHTING COMPANY, Corunna, Mich., has been formed with a capital stock of $20,000. The incorporators are C. M. Nolley, D. M. Lowe, D. C. Nolley, F. Clark and M. Mead.

THE EASTERN CARBON WORKS, Rahway, N. J., has filed articles of incorporation with a capital stock of $200,000. The incorporators are Edward A. Day, of Morristown, and William Mills and William D. Kellogg, of Elizabeth.

THE UNION TELEPHONE COMPANY, Sidney, N. Y., has been incorporated with a capital stock of $6,000. It is proposed to maintain telephone lines between Unadilla and Sidney and Bainbridge, and between Unadilla and South Unadilla Station. The directors are D. R. Buckley, E. O. Allen, Robert Siver, Unadilla; John Spiekerman, M. L. Siver, R. W. Siver and C. M. Wade, of Sidney.

THE WOODBURY & SOUTHBURY ELECTRIC RAILWAY COMPANY, Woodbury, Conn., has been formed with a capital stock of $50,000. The officers of the new company are as follows: President, James Huntington; secretary and treasurer, E. S. Boyd; directors, J. S. Bradley, W. M. Anthony and F. C. Boyd. The road will run from Southbury through Woodbury to Waterbury.

The Telegraph and Telephone.

DOYLESTOWN, PA.—The Standard Telephone Company will extend its line to this city.

WEST BAY CITY, MICH.—The Michigan Telephone Company will soon begin the erection of a three-story brick building to be used as an exchange.

BOSTON, MASS.—The Bell instrument statement for the month ended January 20 shows a gross output of 46,548; net output, 31,829. The total number of instruments outstanding is 1,157,075.

BOSTON, MASS.—It is stated that the Erie Telegraph & Telephone Company will construct 1500 miles of long-distance pole lines and erect 2000 miles of copper wire in the Michigan Company's territory.

LANCASTER, PA.—The board of directors of the Independent Telephone Company, of this city, has organized and elected the following named gentlemen as officers of the company: President, Israel G. Erb; vice-president, P. S. Erb; secretary, H. Reist Landis; and treasurer, W. M. Amer.

YORK, PA.—The York Telephone Company will extend its line to Lancaster, preliminary arrangements therefor having been completed. The Lancaster Company, like the York Company, is an independent concern, and is said to be meeting with great success all over the city and in Lancaster City.

BLOOMSBURG, PA.—The construction of the lines of the Montour & Columbia Telephone Company to connect Sunbury, Northumberland and Bloomsburg with the lines of the Shamokin Valley Company will be commenced at once. This will be the first opposition system established in this section.

PITTSBURG, PA.—Representatives of twenty-six independent telephone companies in the Pittsburg district met in this city on January 24. Mr. J. E. Keelyn, of Chicago, gave the details of a proposed consolidation of all the independent telephone interests. The representatives present, it is stated, were favorably impressed with the idea, and a later meeting has been arranged for to continue the work.

BOSTON, MASS.—The annual report of the Southern New England Telephone Company for the year 1898 shows gross receipts of $644,003 as compared with $595,831 in 1897; expenses and interest, $491,475 against $430,656 in 1897; balance, $152,528 against $165,175. Surplus, $1868, against $14,515 in 1897. The total number of stations in Connecticut is 10,588, an increase for the year of 1213. During the year $90,000 was spent on underground work. Almost all of the old 5 per cent. bonds of the company overdue, and upon which the company held an option payment at 102, have been refunded into the new long-time 5 per cent. bonds.

CHADRON, NEB.—Bartlett Richards, W. G. Comstock and Charles C. Jamison have organized the Ranch Telephone Company, in this city, for the purpose of operating telephone and telegraph lines in the States of Nebraska, South Dakota and Wyoming. These gentlemen, some time ago, built a telephone line 150 miles long between Gordon, Neb., and the various ranches operated by them in the sandhills of western Nebraska. While the enterprise was of a private nature, the proprietors were prevailed upon to make it partake of the nature of a public telephone service. They have established reasonable rates and enabled communication between the leading ranches and various towns, besides this city.

PITTSBURG, PA.—A daily paper of this city states that night half-rate telegrams are rapidly growing fewer and fewer on account of the new fast express trains which leave Pittsburg in the evening. It is possible for business men in Pittsburg to write letters which will be delivered in New York next day about as soon as half-rate messages would be. This class of telegraph business, known as the "red" messages, from the fact that they are written on blanks printed in red, is accepted after 6 o'clock P. M. for transmission over the wires during the night and delivery early the next morning. The idea in establishing this class of business was to provide work for the wires at night, when business is otherwise usually dull. It is also stated that the long-distance telephone system is interfering with the night telegraph message service.

THE NEW DIRECT GERMAN CABLE.—In reference to the proposed direct cable between Germany and the United States, which was mentioned in the last issue of The Electrical World, it is stated that agreements have been made with the American cable companies by which the cable itself must be manufactured in England, and laid by way of the Azores. The American companies in question, it is stated, have pledged themselves to use the new line for the transmission of their dispatches to and from Germany, and the German post office has guaranteed the transmission of a certain number of words; thus the profitable operation of the line is assured. The syndicate which will undertake the laying of the cable was organized at Cologne, and includes Felten & Guilleaume, at Mulheim, the Land & Sea Cable Company, and several German banking institutions. The Land & Sea Cable Company has a share capital amounting to 6,000,000 marks, and has already purchased land on the North Sea Coast for the location of a cable station, and has ordered the building of cable-laying steamers.

Electric Light and Power.

WILLIAMSPORT, PA.—The Common Council has voted against the proposition to establish a municipal electric lighting plant in this city.

TAUNTON, MASS.—The Whitman electric light plant has been sold to Mr. John R. Graham, of Quincy. Several improvements are planned, and the plant is to be extended.

JAMESTOWN, N. Y.—The city authorities are considering the expediency of purchasing the Jamestown Electric Light & Power Company's plant and combining it with the present municipal plant.

SILVER CITY, N. M.—The New Mexico Light, Heat & Power Company, of this city, has recently installed two Northern electric generators direct connected to engines built by the Ball Engine Company, of Erie, Pa.

HARTFORD, CONN.—The Borough of Wallingford has voted to build and maintain an electric light plant of its own. Twenty-year coupon bonds bearing interest at the rate of 3½ per cent. will be issued to the amount of $45,000.

SCRANTON, PA.—It is stated that a deal is under way to combine the interests of the Scranton electric light companies. Mr. Martin Maloney, of Philadelphia, is said to be the prime mover in the scheme. He is actively connected with the Philadelphia electric lighting syndicate.

ALBANY, N. Y.—It is stated that Governor Roosevelt and Speaker Nixon are in favor of establishing a State electric light plant for the lighting of the Capitol and other public buildings. Superintendent of Public Buildings, Mr. Harry H. Bender, has been directed to ascertain the cost of maintaining such a plant. Mr. Bender will report his findings to the trustees as soon as possible.

COLUMBUS, GA.—It is stated that the Columbus Power Company has let the contract to the Stanley Electric Manufacturing Company, at Pittsfield, Mass., for half of the number of generators to be used at the company's new plant on North Highlands. The machines contracted for will have a capacity of about 4500 horse-power, and the contract involves an expenditure of about $60,000.

SYRACUSE, N. Y.—A resolution has been introduced in the City Council authorizing the mayor to appoint six citizens, who shall inquire into and investigate the expediency of the city owning and controlling its heat and light supply. The commissioners are authorized to employ a civil engineer who is skilled in gas and electric construction and competent to advise as to the characteristics of the several gas and electrical plants they may examine.

CHARLESTON, S. C.—Plans for the consolidation of the Charleston City Railway Company, the Charleston & Seashore Railroad Company, the Charleston Edison Light & Power Company and the Charleston Gas Light Company are now completed. The successor company will have a capital stock of $1,500,000, which is 25 per cent. less than the aggregate capital of the four companies. It will issue $2,500,000 5 per cent. consolidated gold bonds. The new company will control all the lighting and railway plants in this city.

NEW YORK, N. Y.—It is stated that the Electrical Company of America, which was recently organized under the New Jersey laws, will absorb all of the small electric lighting and power companies in the Borough of Queens, New York City. The company has recently absorbed the Electric Light & Power Company, of Jamaica. The stock of this latter company has been increased to $1,500,000, which is said to be five times the original amount. The headquarters of the Electric Company are in Philadelphia.

NEW YORK, N. Y.—The San Paulo Gas Company, of San Paulo, Brazil, has decided to erect an electric light plant at once for the supply of current for lighting purposes. It has already entered into an agreement to light the new railway stations in course of erection in that city. The gas company has decided upon this because of the strong position it occupies in San Paulo with the new concession for thirty years, and being in position to raise the capital without difficulty. The company's consulting engineer has been instructed to prepare the plans and specifications and obtain tenders for carrying out the work with the least possible delay. San Paulo has a population of 75,000 inhabitants.

WATER POWER AT CHATTANOOGA, TENNESSEE.—The city of Chattanooga, Tennessee, is agitating the question of the utilization of the fall of the Tennessee River for the development of power. The government is now at work removing boulders and reefs to improve navigation in what is known as the "mountain section" of the river, a division nineteen miles in length immediately below the city. It is now proposed to construct a dam to give a rise of 25 feet to allow slack water navigation over this section. The location of this dam would be less than five miles in a direct line from the centre of the city. With the minimum flow of the river there would be available 10,000 hydraulic horse-power. The local chamber of commerce has asked Congress to employ an hydraulic engineer to prepare plans for carrying out this project.

THE ELECTRIC RAILWAY.

ALLENTOWN, PA.—It is stated that the Allentown & Bethlehem Traction Company will expend $40,000 during the spring in rebuilding its road.

YPSILANTI, MICH.—It is stated that an electric railway will be built between this city and Saline during the next year. The distance is 12 miles. Ypsilanti capitalists are interested in the enterprise.

POTTSVILLE, PA.—The Schuylkill Electric Railroad system is to be extended 20 miles through Long Run Valley from Schuylkill Haven to Pine Grove. Surveys are now being made for the extension.

KOKOMO, IND.—The Kokomo City Street Railway has been sold by the receiver to W. P. Stevens, of Detroit. The price paid was $9000. The company will be reorganized and the line extended.

TRENTON, N. J.—A bill has been introduced in the State Legislature making the words "real estate" in the General Tax Act include, among other properties, poles and supports for electrical conductors, and elevated railways and their franchises; also pipes and conduits.

PORT JERVIS, N. Y.—Mr. C. J. Vaninwegen, of this place, has been appointed receiver of the Port Jervis Electric Street Railway Company on the application of Mr. Elmer P. Morris, New York City, a judgment creditor. The road is about 3 miles long, and has been in operation a little over a year.

KANSAS CITY, MO.—It is announced that the Metropolitan Street Railway Company, of this city, has set aside $1,000,000 to be expended in improvements during the present year. While much of the money will be spent in improving existing lines, a great deal of it will go into the new construction.

HARRISBURG, PA.—A bill has been introduced in the State Legislature to permit traction companies to carry freight, express and mail matter. A provision in the bill requires companies desiring to engage in this class of traffic to secure the consent of the Councils of cities and boroughs in which their lines are in operation.

AKRON, OHIO.—Work on the electric railway between Akron and Alliance has been commenced. The right of way for the entire distance has been secured. Akron capitalists have pledged themselves to take $10,000 worth of stock, and Alliance will subscribe a like amount. The small towns along the line have agreed to take proportionate amounts.

SYRACUSE, N. Y.—The directors of the East Side Traction Company have authorized the acquisition of the Syracuse & East Side Railroad. They also authorized the lease of the East Side road to the Syracuse Rapid Transit Railway Company. The directors of the latter road have authorized the lease, but the stockholders have not yet given their approval.

INDIANAPOLIS, IND.—Another measure designed to limit the powers of street car companies has been introduced in the Senate. It provides that where suburban lines are run the company operating them shall have the right to use the tracks of companies operating in the city or town. If any suburban and city companies cannot agree upon a price to be paid for such use of tracks, then the circuit judge is to fix a compensation to the city company.

PIQUA, OHIO.—It is stated that sufficient capital has been secured to build the electric railway from Troy to Dayton. A company has been organized, and the following gentlemen elected officers: Theodore Sullivan, president; E. H. McKnight, vice-president; Frank Foster, of Middletown, secretary and treasurer. The capital stock of the company will be increased from $25,000 to $500,000. It is stated that the right of way has been secured for the entire distance.

CLEVELAND, OHIO.—An application has been made by several gentlemen well known in this city to construct and operate a new electric street railway, forming a belt line for the west and south sides of the city. The application was made by Messrs. Jacob B. Perkins, Hon. David Morison, Henry W. S. Wood, Henry J. Wietz, M. F. Bramley and William H. Ford. The application was referred to the Board of Control, the corporation counsel and the Committee on Streets and Railways.

HAMILTON, OHIO.—A franchise has been granted to the Hamilton & Eaton Electric Street Railway Company by the County Commissioners. The grant is for a period of twenty-five years, the company to pay the county $10 per mile for the first two years; $20 per mile for the next three years, and $40 per mile per year thereafter. The company is to construct its own bridges and culverts. The franchise is granted on condition that the road be completed within eighteen months.

CHICAGO, ILL.—The Chicago Electric Traction Company, which is the new name of the reorganized Englewood & Chicago Railway, has filed a mortgage for $500,000. Large extensions are contemplated, the company having the privilege of bonding each new mile of single track for $40,000. The road has the right of way on several streets, and it is said that many isolated spots on the far south and southwestern sides of the city will be benefited by the extensions.

MOUNT VERNON, N. Y.—The Union Railroad Company, on the night of February 1, laid a piece of track nearly a mile long in Fourth Street, North Pelham, with which to connect its belt line around the cities of Mount Vernon and New Rochelle. The haste of the company was due to a decision given on January 31 in the Supreme Court that both the Union and New York, Westchester & Connecticut Traction companies have legal franchises on the street. It is stated that the judge expressed the opinion that the company first to begin work would have the right to use the middle of the street, and it was this that led the Union Railroad Company to expedite matters in the manner above indicated.

BALTIMORE, MD.—Touching the matter of consolidation of the street car lines and electric light interests of this city, it is now stated that Alexander Brown, and other gentlemen associated with him in the syndicate, have purchased all the property of the three electric lighting companies in the city. The price reported to have been paid is $3,000,000 in cash. This will give the syndicate full control of the street railway and electric lighting systems in the city. The three electric light companies concerned in the deal are the Brush Electric Company, the Northern Electric Company and the Edison Electric Illuminating Company. The transfer of the properties of the electric lighting companies will take place in about thirty days.

WASHINGTON, D. C.—The annual report of the Capital Traction Company for the year 1898, which has been submitted to the Senate, contains a statement covering the expenditures made in installing the underground electric system on the several lines of the company, which were previously operated by cable. (See THE ELECTRICAL WORLD of December 31, 1898.) The disbursements for the electric installation were $1,296,291.78. Of this amount $438,822.76 was for underground construction and $303,538.44 for car equipments. The company has 514 passenger cars and 393 motor cars. The number of passengers carried during the year was 21,210,854. The total receipts, including a balance on hand January 1, 1898, of $20,777.45, amounted to $1,013,954.42, and the total operating expenses, exclusive of taxes and interest, were 537,990.79. A balance of $64,856.63 is carried over to the new year.

DETROIT, MICH.—Arrangements have been completed whereby Messrs. Westinghouse, Church, Kerr & Co. will finance the bonds of the Lansing, Dexter & Ann Arbor Electric Railway, which it is proposed to have in running order within the next six months. It is expected that bonds to the amount of $1,175,000 will be issued. Messrs. W. W. Churchill, of New York, and C. W. Register and O. A. Stranahan, of Chicago, engineers of Westinghouse, Church, Kerr & Co., have gone over the line of the road to obtain an idea of the probable cost. The Michigan directors of the railway company, of which there are six, have subscribed $250,000 toward the enterprise. Mr. Emerson McMillin, of Detroit, is thought to be interested in the road, but to what extent is not yet known. The capital stock of the company is $250,000. The projected road is to run from Ann Arbor through Dexter and Mason, and a number of other intervening towns, and connect with the present Detroit,

Ypsilanti & Ann Arbor road, making a complete electric line from Detroit to the State capital, of over 80 miles in length.

Legal Notes.

INJURIES OCCASIONED BY FRIGHT.—In the case of O'Flarity vs. the Nassau Electric Railway Company, involving the question of the allowance of damages for personal injuries occasioned by fright, which has been quite a vexed question to the courts within the past few months, the New York Supreme Court held that a recovery cannot be had for injuries occasioned by mere fright, but that such rule does not apply where, as in this case, the fright was occasioned by, and accompanied by, an electric shock, to which plaintiff was subjected while a passenger on one of its cars through the negligence of the defendant.

PHYSICAL AND MENTAL SUFFERING.—The Indiana Supreme Court, in the case of Hillaker, administrator, vs. Citizens' Street Railway Company, decides that an administrator cannot maintain an action on account of the physical suffering and mental anguish caused his decedent by the negligent infliction of personal injuries, for the right of action for such damages dies with the sufferer. The deceased fell under the cars and was so badly injured that he died. He had no relatives, but owed a board bill, and the landlord qualified and sued for $10,000 damages. The difference between the creditor's bill and the damages asked was to cover mental suffering, but the court decides that to be personal and dies with the sufferer.

PERPETUAL FRANCHISE.—In the rank and extended litigation between the Citizens' Street Railway Company, of Indianapolis, and the City Railway Company, the evidence showed that the former was organized in 1861, and by virtue of several ordinances had a franchise of thirty-seven years, which will expire in 1901. In the original act of 1861 the first company was declared to be "a body politic and corporate in perpetuity," but in another section the City Council reserved to themselves the exclusive powers "now" exercised over the streets, etc., within the corporate limits of Indianapolis. The query was sprung as to whether, after the expiration of the thirty-seven years (1901), the Citizens' Company might continue, without first procuring the consent of the City Council. The Supreme Court, to which the case has been twice appealed, in the latest decision on that branch of the question, says: "It would never do, as seems to us, to admit that by first agreeing to allow the company to enter upon its streets, and continue there for a definite term, the city had thereby given up forever that exclusive control over its streets which the same section of the act says shall never be impaired by any construction that may be given to the statute. As well contend that the landowner, by allowing a tenant to enter upon and cultivate his farm for a limited period, has thereby lost forever the right to reoccupy it himself, even after the time prescribed in the lease has expired. The very circumstance, too, that the statute provides for the consent of the city to the exercise of the franchise implies that the city may give or refuse such consent, according to its own discretion, and if it gives consent, such consent may be with such limitations and conditions as the city may deem consistent with its own welfare and the welfare of its citizens. It is not contended that in giving consent the city may not make all reasonable requirements as to location of rails, running of cars, kind of motive power, repair and improvement of streets occupied by tracks, amount of fare charged, and numerous other details; and it is inconceivable that the much more important consideration as to the length of time during which the company may occupy the streets should not also be in the control of the city. Moreover, the company, by accepting the original grant for thirty years, given in the ordinance of 1864, and also in seeking and accepting the extension of that grant for seven years longer, given in the ordinance of 1880, has, in conjunction with the city, put a practical construction upon the act under which it claims corporate existence. It would hardly be consonant with common honesty, as practiced between man and man, to seek for and enter into a contract, first, for thirty and afterwards for thirty-seven years, and then, when the right had been enjoyed for the time stipulated and agreed to, to turn around and claim that the contract was without a time limit—that the tenant for a term of years, being once in, had thereby become the owner of the fee simple. We have no doubt, therefore, that the right of the Citizens' Company to exercise its franchise will terminate on January 18, 1901. The court cites the forcible argument of Federal Judge Baker to the same effect, in 64 Fed. R., 656-58. Argument similar in nature was adduced by the traction company, of Chicago, claiming that its franchise was perpetual, and that it could run its cars forever. Such propositions are regarded by the court as startling and absurd, and the only wonder is that they are brought forward with any degree of confidence whatever.

Personal Notes.

MR. GEORGE A. HAMILTON, chief electrician of the Western Electric Company, sailed for Europe on the steamer "St. Paul" on February 1. Mr. Hamilton will visit England and France on business for his company.

MR. FREDERICK B. COREY, secretary of the Springfield Elevator & Pump Company, Springfield, Mass., has accepted a position as mechanical engineer with the Stilwell-Bierce & Smith-Vaile Company, Dayton, Ohio. Mr. Corey will retain his position with the Springfield concern.

MR. W. F. D. CRANE, who has been identified with the electrical department of the H. W. Johns Manufacturing Company, New York, for the past seven years, has recently severed his connection with that company, and has joined the engineering staff of the Electric Vehicle Company, 1684 Broadway, New York.

MR. W. W. CHURCHILL has been appointed to the position of mechanical engineer for Messrs. Westinghouse, Church, Kerr & Co. He has been closely associated with all of the largest engineering work of this firm, including the Boston Terminal and the Third Avenue Railway power plants, and well deserved the place and title which has been given him. He is a graduate of Cornell University, and has been with Westinghouse, Church, Kerr & Co. some nine years, he having remained at Cornell one year as Sibley Fellow in Mechanical Engineering.

MR. HENRY J. CONANT, manager of the Boston office of Messrs. Westinghouse, Church, Kerr & Co., has been advanced, and the scope of his duties has been increased, and while he will continue to reside in Boston his work will be of a broader nature and connected with the general affairs of the concern. Mr. Conant has of late been particularly well known in connection with the execution of the large general engineering contract at the new Boston Terminal, of which he had complete charge in both management and engineering. He is a graduate of the Massachusetts Institute of Technology, and by his many years of work with Westinghouse, Church, Kerr & Co. is peculiarly well fitted for the larger duties now entrusted to him.

Educational Note.

NOTES OF THE UNIVERSITY OF MINNESOTA.—On January 26 Mr. Truman Hibbard, general manager of the Willow River Electric Light & Power Company, Hudson, Wis., gave a lecture before the College of Engineering of the University of Minnesota, on the subject of "Hydro-Electric Power Plants," discussing certain features of three-phase and monocyclic systems for transmission and distribution purposes. Mr. Hibbard gave an interesting account of the power plants under his charge, showing the great flexibility of electrical apparatus. In two cases the plant is reinforced by 600-volt, direct-current motors, driven by generators at other waterfalls not far distant, in one case the distant wheel and generator being controlled from the principal station. He described a novel arrangement of secondaries by which a monocyclic generator may be used in emergency to supply three-phase circuits through the regular transformers. The Electrical Engineering Museum has recently received a number of pieces of station auxiliary apparatus secured from the Minneapolis General Electric Company, showing various steps in the development of lightning arresters and switchboard apparatus. A Heisler two-phase alternator recently secured is being modified for experimental use, a system of switches being arranged to permit ease and rapid changing from 100 volts to 1000 volts at will, thus enabling the use of both pressures at the same time.

Trade and Industrial Notes.

THE FRANKLIN ELECTRIC COMPANY, Franklin, Ky., has recently put its new plant in operation. The engine which furnishes the power was built by the Ball Engine Company, of Erie, Pa.

THE WARREN ELECTRIC & SPECIALTY COMPANY, Warren, Ohio, has increased its capital stock from $50,000 to $100,000. It is the company's purpose to manufacture electrical specialties under its own patents.

THE WARREN ELECTRIC MANUFACTURING COMPANY, Sandusky, Ohio, has been awarded the contract for furnishing three alternators for the new electric light plant to be installed by Messrs. Armour & Co. at the Chicago stock yards.

THE GLOBE CARBON WORKS, Cleveland, Ohio, have decided to increase their capital stock from $100,000 to $250,000. The old officers have been re-elected, with the addition of Messrs. S. C. Holding and B. L. Britton, of Cleveland, as directors.

THE CHICAGO FUSE WIRE & MANUFACTURING COMPANY, 154 Lake Street, Chicago, and 853 Broadway, New York, is offering to the trade something interesting in the way of railroad fuse links. The goods manufactured by this company are considered first class.

THE PERRY-PAYNE BUILDING, one of the most prominent in Cleveland, Ohio, recently added to its electric plant a 50-kw Walker generator direct connected to a 100-hp engine built by the Ball Engine Company, of Erie, Pa. This is the second Ball engine supplied for this plant.

A USEFUL DESK CALENDAR.—The Bibber-White Company, of Boston, Mass., has gotten out a neat and useful desk calendar for 1899. It stands on a desk, easel fashion, and contains movable monthly calendar cards. At the right of the frame, which is leather covered, is a thermometer. The calendar frame measures 4⅜x35 inches, hence it takes up little room.

THE AMERICAN CARBON COMPANY, Noblesville, Ind., through its Eastern agent, Mr. Paul Whitehead, has closed a contract for 14,000,000 carbons to be supplied to electric lighting companies in New York City. This supply will provide all of the high-tension arc lamps in Greater New York with carbons for two years. It is thought that this contract is the largest ever made in this country for electric light carbons.

THE AMERICAN ELECTRIC VEHICLE COMPANY, of Chicago, according to a press dispatch, on February 1 closed a contract to supply carriages for some of the Bombay princes. The order aggregates $26,000, and it is stated that the vehicles will be shipped during the summer. It is reported that the company is estimating on the cost of twenty electric stage coaches for the Fifth Avenue stage line in New York.

THE ELECTRIC APPLIANCE COMPANY is very proud of its new building at 92 and 94 West Van Buren Street. It claims that its new location gives it the largest electrical supply house in the country, with unequaled facilities for doing business and carrying very large quantities of material. The building is about 50 by 90 feet, has five floors and basement, with light on three sides, and is an ideal building for any line of business. It should be visited and inspected to be appreciated.

THE HOLTZER-CABOT ELECTRIC COMPANY, Boston, Mass., in catalogue No. 35, just issued, describes its magneto bells, hand and power generators, motor generators and telephone apparatus of all styles. Some very excellent illustrations are used in the get-up of this catalogue, which show the details of construction of the various apparatus to very good advantage. The catalogue bears evidence of having been compiled with great care. Many of the illustrations are entirely new.

MR. WILLIAM E. QUIMBY, 86 Liberty Street, New York, manufacturer of the Quimby screw pumps, has received an order for two of his No. 10 pumps, each to have a capacity of from 800 to 1000 gallons per minute, with direct-connected electric motors of sufficient power to pump against 150 pounds to the square inch. These pumps were purchased by the Chicago City Railway Company, and are to supply water for the largest electric fountain in the world, to be erected in a park in the southern part of the city.

THE GENERAL ELECTRIC COMPANY, LTD., London, England, has issued a complete catalogue of the goods handled by it. The catalogue consists of a large volume of no less than 1440 pages. It includes everything in the way of electrical supplies, dynamos, motors, transformers, engines, boilers, electric heating apparatus, electrical fixtures and glassware, electric bells and accessories, telephones and electro-medical supplies, etc. Besides these the catalogue contains a great deal of information concerning electrical principles and their practical application.

MULTIPOLAR DYNAMOS AND MOTORS.—The C & C Electric Company, 143 Liberty Street, New York, has issued Bulletin No. 128, in which illustrations and a brief description are given of this company's type "M P" multipolar dynamos and motors. The bulletin is complete in its information as to the various machines referred to. Tables of dimensions, together with diagrams of the machines, are given. Various details are also illustrated, among them being the reaction brushholder. This brushholder was described and illustrated in THE ELECTRICAL WORLD of July 23, 1898.

MR. HUGO REISINGER, the importer of the "Electra" highest-grade Nuernberg carbons, says that the change now taking place in electric arc lighting is strikingly shown by the enormous and increasing demand for "Electra" carbons. This is largely due to the rapid introduction of enclosed long-burning arc lamps for direct-current, alternating-current and series lamps. It has become necessary to run the Nuernberg carbon factory night and day to keep up with the orders that are sent from this country, while at the same time the demand for carbons for the constant-potential, direct and alternating current open-arc lamps shows no falling off. The above facts tend to show that the enclosed long-burning arc lamp is rapidly superseding the incandescent lamp for interior use, while it is also driving the series, high-tension, open-arc lamp from the streets.

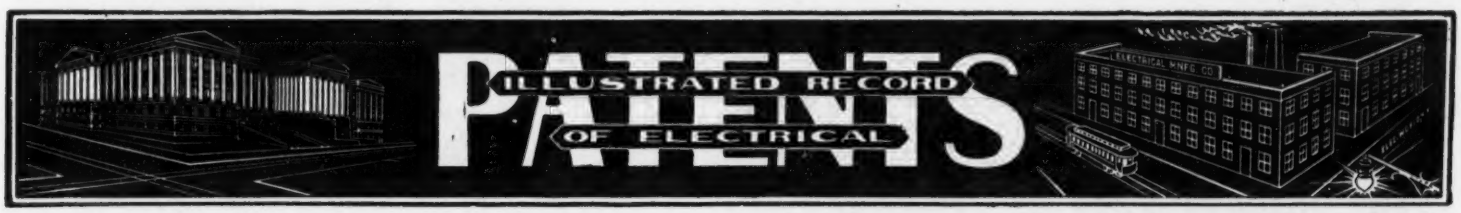
STEAM AND ELECTRIC HOISTING ENGINES.—The C. W. Hunt Company, 45 Broadway, New York, has added another catalogue to its list of trade publications. The latest addition, Catalogue No. 9902, deals with steam and electric hoisting engines. The illustrations of the electric engines include one of a 20-hp electric conveyor driver, built for the Boston Electric Light, Heat & Power Company. The Hunt Company builds electric hoisting engines of various sizes to correspond with steam hoists of like sizes, but makes special hoists for greater or smaller weights, or variations in the speed of hoisting. The motors are wound for 110, 220 or 500 volts, according to the current used. The hoisting speed is varied by controllers and resistances of standard types, and the motor is protected by a circuit breaker, which cuts off the current in case of overload.

THE AMERICAN FUEL ECONOMIZER is very completely described and illustrated in the catalogue issued by Messrs. Broomell, Schmidt & Co., Ltd., York, Pa., who manufacture this apparatus. The American fuel economizer is a sectional multiple water heater set up in a flue or passage leading from the boilers to the chimney. It is so arranged that the feed-water for the boilers is pumped into it at the end farthest from the boilers, and is discharged at the opposite or hot end of the economizer and delivered into the boilers very hot, from 225 to 350 degrees. These economizers can be attached to any type of boiler without stopping the works. In the design of this economizer all packed joints have been eliminated and taper fits are used throughout. A very complete description of the construction of the apparatus is given and various detail illustrations enable a very clear understanding of the device and its operation. Diagrams are given showing the application of the American economizer to various types of boilers.

ELECTRIC HEATING.—The heating department of the Simplex Electrical Company, Sidney and Franklin Streets, Cambridgeport, Mass., has just issued a very complete and well-illustrated catalogue of its extensive line of heating devices. This company is sole manufacturer under the patents of the American Electric Heating Corporation. The line of goods manufactured by it includes electric radiators, stoves, kettles, stew-pans, coffee-pots and all the different classes of cooking utensils in general use—electric ovens, immersion-coil heaters, immersion-disc heaters, smoothing and tailor irons, heating pads, glue-pots, soldering irons, etc., etc. The catalogue gives a great deal of information on the subject of electric heating and cooking by electric heat, and while this particular use of electric current is generally more expensive than the production of the same amount of heat by the older, but more wasteful methods, there are many instances where electric heat is preferable, notwithstanding its higher cost. The features and advantages of the various devices illustrated are pointed out concisely and clearly, and the sizes and capacities, together with prices of each, are also given. Anyone desiring to use any of the electric heating devices is enabled by this catalogue to tell just what may be expected of them under practical conditions. The catalogue is an important addition to the literature upon electric heating.

THE AMERICAN ELECTRICAL NOVELTY & MANUFACTURING COMPANY, 255 Centre Street, New York, announces that it has taken proceedings against two infringers of its patents on its "Ever Ready" electric flashlight, and that it proposes to prosecute all infringers, whether manufacturers, sellers or purchasers. This company manufactures a line of electrical novelties that is meeting with much popular favor. The "Ever Ready" electric light is a handy device, and, as its name implies, is always ready for use. It is cylindrical in shape, with lamp and reflector at one end, and battery at the other—all inside of the case. It is self-contained, and the simple pressure of the ring, on one side, against the band, closes the circuit, and a brilliant light shines from the end of the tube. This outfit is made in three sizes, viz.: 1½x8½ inches (pocket size), 1½x11 inches, and 1½x13 inches. The lamps give from 6000 to 10,000 lights before the renewal of the battery is necessary. They are very useful, and their compactness and portability are very valuable features. The company's products include, besides the lamps above referred to, "Ever Ready" surgical and dental lamps, electric bicycle lamps, night lights for a small clock or watch, with stand, electric gas lighters, Statue of Liberty, with electric torch (a parlor ornament or for counter and advertising display), cigar lighters, electric candles, electric ruby lamp (for amateur photographers), etc., etc.

DUTY ON ARC-LIGHT CARBONS.—Collector George R. Bidwell has been notified by the Treasury Department at Washington that the Government's appeal in the case of the United States v. Hugo Reisinger and the United States v. Dingelstedt & Co., and Dingelstedt & Co. v. the United States (cross appeal) have been decided in the United States Circuit Court for the Second Circuit adversely to the Government. The merchandise involved in these suits consisted of arc-light carbons imported under the provisions of the tariff act of August 28, 1894, and classified for duty under paragraph 86 of that act, under the enumeration for "all articles composed of earthen or mineral substances, including lava tips for burners not specially provided for," 30 per cent. ad valorem. The importers protested, claiming the merchandise to be properly dutiable at 20 per cent. ad valorem as "non-enumerated manufactured article" under section 3 of said act. This claim was sustained by the United States Circuit Court for the Southern District of New York on the original trial of these cases, and appeals were directed as above stated. The opinion of the Circuit Court of Appeals says: "We concur with the Circuit Court in the conclusion that the arc-light carbons in question are dutiable as 'articles manufactured in whole or in part not enumerated or provided for in the act' at 20 per cent. ad valorem. The decision of the Circuit Court is affirmed."



UNITED STATES PATENTS ISSUED FEBRUARY 7, 1899.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

11,713. STORAGE BATTERY; R. Ashley, of Port Republic, N. J. App. filed October 5, 1897. A secondary or storage battery, comprising the non-conducting cups or trays superimposed upon but out of contact with each other, the positive and negative electrodes secured thereto, the perforated separating plates, the asbestos sheet and the conductors secured to said negative electrodes, and running up the outside and then down the inside of the cup or tray above and secured to the positive electrodes thereon, substantially as described.

618,404. ELECTRIC PUMP; C. Eickemeyer, of Yonkers, N. Y. App. filed January 22, 1898. A gear provided with an annular groove near its teeth for returning the lubricant for the teeth and preventing the same from passing onto the gear-shaft.

618,429. ELECTRIC RAILWAY; J. F. Munsie, of New York, N. Y. App. filed July 26, 1897. In a surface contact electric railway a multiplicity of pairs, of boxes along the track, one box of each pair containing circuit-controlling devices and the other box contact-spots.

618,509. CARBON-FEEDING MECHANISM; E. P. Hopkins, of New York, N. Y. App. filed March 21, 1898. In a constant-potential arc-lamp, the combination with the carbons, of an electric motor, the armature of which is connected to both of said carbons, two field-coils for the motor oppositely wound and of the same ampere-turns connected normally in series with each other in a shunt across the arc, two short-circuiting stops, one of said stops being adjustable, a contact piece adapted to engage with either of said stops for short-circuiting one or the other of the field-coils, a shunt-regulating magnet, the armature of which is connected to said contact-piece, a retractile spring for retracting said armature, and a counteracting spring carried by the armature for counteracting the retractile spring.

618,526. FIRE-ALARM; F. D. Wallace, of Wheatland, Ind. App. filed June 1, 1898. In a device, the combination with a lever, having a weighted end and pivoted upon a standard arranged to form one terminal of an alarm circuit, of a second terminal arranged in the path of movement of said lever, means for holding a fusible plug or stop in position to maintain said lever out of its normal position, and a shield carried by said lever in position to project over such plug and thereby protect the second terminal.

618,534. TROLLEY; D. J. Brown, of New York, N. Y. App. filed December 1, 1897. The combination with a trolley-pole having side plates at its free end, a trolley wheel journaled between said plates, guide arms carried by the journals of said wheel, detachable side pieces carried by said guide plates and an arm yieldingly held in each of said pieces, substantially as described

618,562. VENTILATING APPARATUS; F. P. Donahey, of Washington, D. C. App. filed August 10, 1898. The combination with the motor and the arm controlling the same, of a rotary valve carried by said arm, a spring acting upon said arm, and a gear provided with a projection to engage said arm to move it in opposition to its spring

618,577. TROLLEY-SLEETER; J. B. Mock, of Fort Wayne, Ind. App. filed January 28, 1898. In a trolley-sleeter, an ice-clearer, consisting of a metallic bar formed and curved to lie within part of the groove of the trolley-wheel and provided with a groove for the wire, the groove forming cutting edges to cut the ice; an arm for holding the same in place secured pivotally to the trolley pole, and means to hold the arm in and out of position without changing its connection to the pole.

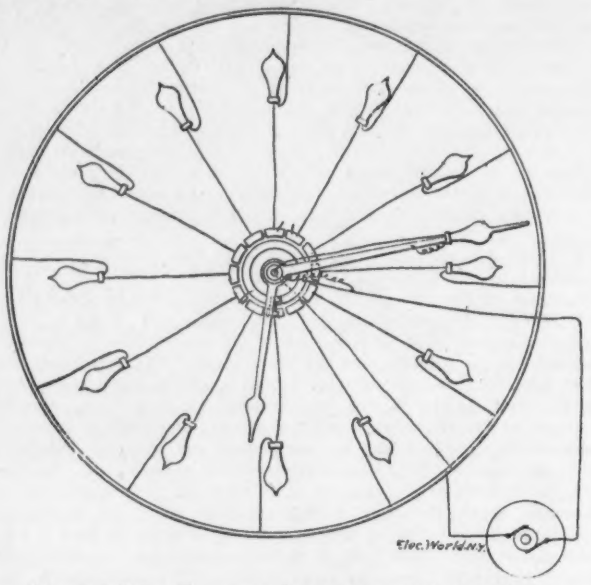
618,578. ALTERNATING-CURRENT MOTOR; E. C. Newcomb, of Brookline, Mass. App. filed May 16, 1898 In an alternating-current motor, a field magnet whose numbers of ampere turns gradually diminish from the outer edges of the poles to the centre, by a sine function.

618,579. COMMUTATOR SHORT-CIRCUITER; E. C. Newcomb, of Brookline, Mass. App. filed June 21, 1898 The combination with a commutator, of a conductor adapted to come into contact with the segments of the commutator, a handle, rotatable relatively to the commutator, for moving the conductor away from the commutator, and means for locking the said handle to said shaft in the "on" and "off" positions.

618,610. TELEPHONE-SWITCHBOARD; J. M. Overshiner, of Elwood, Ind. App. filed October 10, 1898 The combination in a switch-board, of an annunciator drop and signaling device, of means for automatically locking the signaling device when the drop falls.

618,635. ELECTRIC BATTERY; A. R. Adams, of Surrey, England. App. filed March 29, 1897. The process of compounding an exciting fluid for electric batteries, consisting in preparing, first, a chromate solution, adding sulphuric acid, then adding a solution of a nitrate of the alkali metals, then adding a solution of mercury salt, and then mixing thoroughly at a temperature of about 150 degrees Fahr., substantially as described.

618,646. ELECTRIC ILLUMINATED CLOCK DIAL; R. T. Crane, Jr., of Chicago, Ill. App. filed February 18, 1898. The combination with a clock dial and an indicating pointer moving over the same, of means for illuminating the indicating characters successively and synchronously with the registration therewith of the pointer.



No. 618.646 —Electric Illuminated Clock Dial.

618,670. ELECTRIC CLOCK; W. H. Hastings, of Jersey City, N. J. App. filed November 24, 1897. In an electric clock, the combination of the pendulum rod, swinging pawl movably mounted thereon that forms part of an electric circuit, and means for closing the circuit operated by said pawl when limit of movement of the rod reaches a predetermined minimum point, substantially as described.

618,674. TROLLEY WHEEL AND SUPPORT; W. P. Holt, of Savannah, Ga. App. filed June 2, 1898. The combination of a trolley pole, a gimbal support for the wheel carried by said pole, a trolley wheel mounted in said gimbal support, and a weight rigidly suspended from said gimbal support, substantially as described.

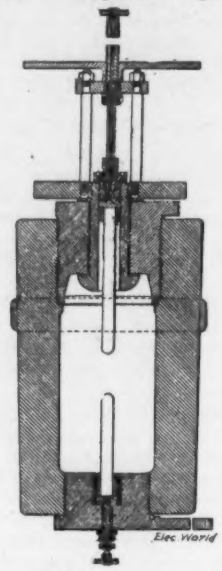
618,679. AUTOMATIC STOPPING MECHANISM FOR ENGINES; V. E. Hunter, of Cleburne, Tex. App. filed May 20, 1898. The combination with a rotary shaft, of a wheel or pulley mounted thereon, a fulcrum post extending radially outward from the rim thereof, a guide post also extending radially outward from the rim and provided with a longitudinal slot terminating in an end-cross piece, a curved centrifugal arm pivotally connected at one end to the fulcrum post and passing at an intermediate point through the slot in the guide and limited in its outward movement by said cross piece, and a spiral spring interposed between the centrifugal arm and the rim of the wheel or pulley for normally holding said arm inward, substantially as described.

618,704. METHOD OF MANUFACTURING FILAMENTS FOR ELECTRIC LAMPS; Hiram S. Maxim, London, Eng. App. filed November 8, 1898. Process of manufacturing high resistance filaments for electric lamps, which consists in subjecting solid or liquid carbonic acid and carbon in a closed vessel under great pressure to the action of the voltaic arc, thereby converting the carbon into a dense crystalline form, comminuting the resulting product, mixing the same with a suitable binder, molding the mixture into filaments and finishing the filaments in the usual manner, as hereinbefore set forth.

618,706. ELECTRIC LAMP; J. S. Mead, of Mt. Vernon, N. Y. App. filed September 19, 1898. In an electric lamp, a casing, a battery in the casing, a reflector arranged in said casing and having a lamp socket, a block of insulating material, a contact plate secured to the rear side of the block, fingers extended from the front of the block and connected to the reflector, whereby the said block and contact plate are supported by the reflector and removable therewith from the casing, a contact point on the reflector and a circuit closer for closing the circuit through the contact point and plate.

618,723. SIGNAL MECHANISM; H. W. Peirce, of Waltham, Mass. App. filed July 7, 1897. The combination with a box, and the vibrator thereof, of the detent, pivoted to the box, having the weight and latch, the plate secured to the top of the box and in electric connection with one arm of an electric circuit, the arm being pivotally connected to said plate by the spring hinge and adapted to be engaged by the detent and the spring jack connected with the opposite arm of the circuit, and adapted to engage the arm.

618,727. ARMATURE FOR DYNAMO-ELECTRIC MACHINES; E. D. Priest, of Schenectady, N. Y. App. filed August 26, 1898. An armature for

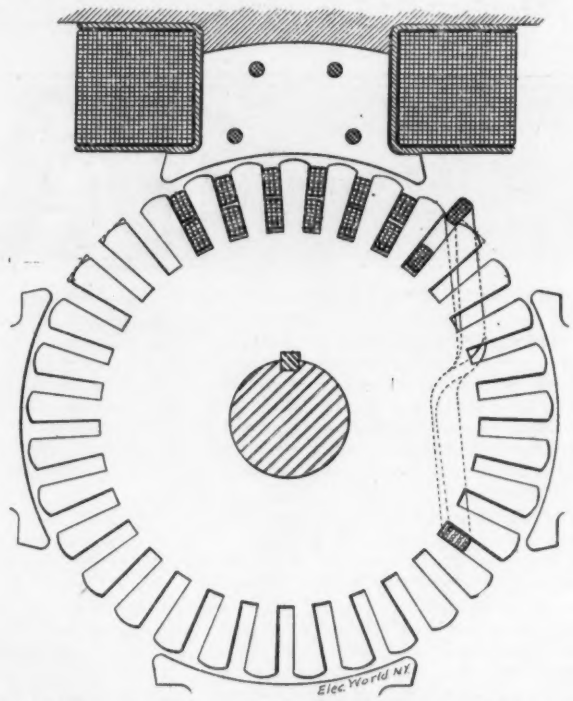


No. 618,704.—Method of Manufacturing Filaments for Electric Lamps.

a dynamo-electric machine, comprising a toothed body of iron, having straight-sided slots, and designed to receive a number of coils, the teeth being so arranged that they are highest in the centre and decrease in height toward their outer edges.

618,773. AUTOMATIC CIRCUIT CLOSER; H. F. Blackwell, Jr., of New York, N. Y. App. filed January 8, 1898. In an alarm box, a main circuit, an auxiliary circuit, an alarm circuit, a switch normally closing the main circuit, a cam for moving the switch to close the alarm circuit, a rack for rotating said cam, and an electro-magnet in the auxiliary circuit for controlling the rack.

618,812. ELECTRICAL PROTECTOR; D. J. Cartwright, of Boston, Mass. App. filed January 11, 1897. In an electro-magnetic strong-current protector for electrical devices, the combination of an electro-magnet, a block of hard carbon on the end of the same and connected to and forming part of



No. 618,727.—Armature for Dynamo-Electric Machines.

a circuit when the armature of the magnet is attracted, an armature attracted by said electromagnet, a block of hard carbon the armature and opposite to the other carbon block and a resistance of copper or other metal whose resistance increases as its temperature increases electrically connected to said armature and forming part of a circuit through a shunt established when the said armature is attracted.